The Foundry Trade Journal
AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 16. **FEBRUARY, 1914.** **No. 146.**

PUBLISHED THE FIRST WEEK IN EACH MONTH

Subscription Terms: 7s. 6d. per annum, post free.

To place the "**Journal**" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop at the reduced rate of **5s.** per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY

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NOTES AND COMMENTS.

Complexity in the Constitution of Non-Ferrous Alloys.

Without going deeply into the question of the micro-structure of non-ferrous alloys in relation to composition, we would like to put forward a plea for greater simplicity in commercial alloys. Of late years there has been a tendency to adopt for various purposes alloys of 5 or even 6 constituents, sometimes with the object of greater strength, ductility or wearing qualities, and sometimes with a view to obtaining some special colour in the final metal. There are, conceivably, cases in which the practice is justified by the results obtained, particularly when colour and mechanical strength are both matters of consideration; but we are of the opinion that in the great majority of cases where such complex compositions are employed—certainly where mechanical properties are the main concern—equal if not better results could generally be got with a ternary and sometimes even a binary alloy.

It may here be stated that this contention leaves out of the question the use of scrap-metal alloys of uncertain composition where cheapness of material is aimed at, and the ultimate strength is subordinate. There are, of course, large quantities of castings made of such irregular materials, the composition of which may vary with wide limits in the same class of work. This is merely a commercial question, and provided the castings come up to a moderate standard, nothing more is required. The actual composition may be quite complex, as many as six elements being present in more or less influential amounts; and for this reason, amongst others, the use of such metal is confined to unimportant work. The production of alloys to meet specific mechanical and physical requirements in the most efficient manner, however, is a very different matter. Exception may also be made in the matter of additions of materials for purely deoxidising purposes, where such additions do not remain finally in the metal and affect the constitution of the alloy. But it must be remembered that so-called deoxidisers are sometimes added in such quantities as to have the double effect of removing the oxides and leaving a balance which alters the constitution of the alloy.

To return to the question of complex alloys, we have yet to find the casting alloy of more than three constituents that gives consistently better results than a ternary alloy. This is not to contend that no more complex cast alloy can be made to give, say, higher tensile strength than a ternary alloy; it is rather to state that a more complex alloy cannot be made to give consistently those better results in foundry work. This claim would not perhaps be correct were foundry conditions different. If it were at present practicable to melt and mix the constituent metals at controlled temperatures, in *vacuo*, or at least in a neutral atmosphere, and also to cast the alloy at a definite temperature in a similar atmosphere, then it is quite conceivable that highly-complex alloys could be successfully employed. But

even then the extremely difficult question of rate of cooling is involved, and would have to be thoroughly understood and its phenomena accommodated; for, as is well known, the constitution of an alloy may be entirely changed and with it the physical properties, too, by altering the rate of cooling. Under existing foundry conditions, however, there is little chance of casting alloys in the manner suggested; and attention must accordingly be paid to those conditions which militate against success with complex alloys.

In the first place, there is probably no mixture made in the foundry which retains in the castings the same composition or proportions of the constituent metals as characterises the first mixture. This is well appreciated in working with the copper-zinc series, where volatilisation of zinc is a factor which has regularly to be reckoned with, to an extent varying according to the conditions of time and temperature in melting and pouring. But apart from simple volatilisation of one constituent, which might be calculated for with fair accuracy, there is oxidation to be considered. This trouble, also, does not take the same form with all metals; for while zinc oxide is comparatively easily removed with the skimmer, the copper oxide is readily absorbed by the copper itself, and requires to be removed by chemical means—by combining the oxygen with some other element for which it has a greater affinity and the oxide of which can be more easily removed. As is well understood, zinc in a copper-zinc alloy serves this purpose unless the oxidation is excessive. Aluminium oxides, on the other hand, being of about the same specific gravity as the metal itself, are liable to be mechanically trapped.

It will readily be seen that with a complex mixture of metals, each with a different volatilisation point and each having a different affinity for oxygen, the actual resulting composition may be far from the calculated composition, with the result that the special properties of the specific alloy aimed at are not obtained. A fair case in point is that of Duralumin, an alloy which created much interest a year or two ago on account of its lightness and great physical properties in the form of rolled material. From analyses made by different investigators, however, even in that form there is evidently some variation in the actual composition. The tensile strength of the cold rolled sheet has been stated as up to 39 tons per sq. in.; the specific gravity of the alloy being only about 2.8. But despite the good results obtained with the alloy as a rolled material, it is of little value in the foundry. The good properties which characterise it when made under the conditions mentioned are lost on re-melting; and this will be better understood when it is recalled that the composition includes (according to one analysis) aluminium (about 94.5 per cent.), copper (about 4 per cent.) and small quantities of iron, magnesium, silicon and manganese. To what extent the latter are added and how far they are effective as deoxidisers and are thus eliminated we are not in a position to say; but it is evident that they remain in sufficient quantities to give a complex constitution which is correspondingly susceptible to uncontrollable influences during re-melting and solidification. It will, of course, be understood that this alloy is not offered as a casting alloy; but the facts mentioned will illustrate the difficulty in dealing with complex compositions.

It is gradually becoming appreciated in the foundry world that special properties which are found experimentally in alloys are as likely to be the result of special conditions as of the composition. The wide range of properties obtainable from one composition by means of thermal treatment bears out this contention. With the wider application of the information afforded by the diagrams of thermal equilibrium of the various series of alloys, it is quite reasonable to believe that complexity of composition will be less countenanced in the future than in the past. Whether eventually there will be developed reliable diagrams of some of the present alloys of numerous constituents, it is futile to conjecture; there is too much yet to be proved in connection with the simple ones. But what has so far been proved by various investigators in this direction all points to the hopelessness of attempting to so control the conditions of founding complex alloys as to get reliable results, even where the constitution and its thermal developments are understood. Practice has so far shown the most reliable and best physical results (at any rate so far as foundry work is concerned) with the binary and ternary alloys.

What About the Carbon?

On another page we give an abstract of a Paper recently presented before the American Society of Mechanical Engineers, dealing with cast-iron for machine-tool parts. The information is interesting as examples of American practice in this work, and a number of points of use to British founders are included; but there is one noticeable omission which greatly detracts from the value of the information given. Different makers quote the analyses of the irons they use, but in only one case is any mention made of the carbon contents, and then it is merely stated that "While the carbons are not noted as a rule, we get a check on these every once in a while, showing the total carbons about 3.5 to 3.6." Now, we do not speak with authority on American irons, and since there are distinctions between American and British blast-furnace practice and pig-casting methods, the former may be subject to rules of their own; but we should candidly class any such incomplete analyses of British irons as useless. It is to repeat the elementary to state that the influence of silicon, sulphur, phosphorus and manganese (particularly silicon) is important as affecting the carbon in the iron. It therefore becomes essential to know what quantity of carbon there is present to be influenced. There appears to be a widely-spread idea that if the Si., S., Mn., and P. are controlled the carbon will look after itself. This is a grave mistake, for while under regular conditions the influence of those metalloids may be fairly expected to consistently control the condition of the carbon, that is very different from controlling the amount of carbon absorbed by the iron in the blast furnace; there the rate of operation, method of charging, class of ore, heat of blast, and various other factors are influential. It is therefore most essential in discussing the analyses of irons to consider first the total carbon; the constituent upon which the influence of the silicon and other elements is mainly exerted is of prime importance if these latter are to be credited with any value at all.

The Paper quoted above is a good example of the hard way in which old fallacies die. It would appear that the contention (which, we believe, originated in America), that silicon content is the main consideration in mixing foundry irons, regardless of total carbon, still has a hold on American foundrymen. There is surely sufficient evidence to the contrary now available to refute that suggestion. The chill-casting of pigs in America, of course, introduces a factor somewhat foreign to British founders, and gives fracture a somewhat different significance; but when this is taken in conjunction with such disregard of carbon contents as above noted, it is small wonder that American foundrymen, to use their own phrase, are "up against the hard and soft problem."

Construction of Gas-Fired Tempering, Annealing and Melting Furnaces.*

In hardening, annealing and tempering furnaces, we have to consider processes where a large amount of heat at a moderately low potential is required. It must be remembered that this soaking process necessarily requires a big body of heat. With regard to the annealing of brass and steel stampings, it was at one time quite a prevalent idea among manufacturers that no such work could be carried out unless in a closed muffle; it being maintained that were such work carried out in furnaces of the oven type the oxidation of the material would be excessive. Such might be the case if furnaces fitted with air-blast burners were under consideration. With the development of the oven furnace fitted with atmospheric burners, however, all such ideas have long been exploded; and it is now an established fact that to obtain best results the oven furnace must be used.

In the oven furnace, with the bottom slab heated by the large flames from atmospheric burners, we obtain just the effect that is required by these soaking processes, the poorly aërated flame which partly envelopes the work being an absolute necessity for the best results to be obtained. Further, if suitable arrangements are made to enable the amount of secondary air entering the furnace to be controlled,

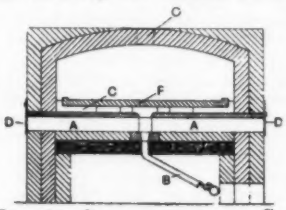


FIG. 1.—SECTION THROUGH GAS-HEATED OVEN FURNACE.

then the work can be carried out with a minimum of oxidation; for it will be understood that if such a furnace be run with the damper so adjusted that a slight back pressure is obtained, and if the amount of secondary air entering the furnace is only just sufficient for complete combustion of the gas, then the work is continuously sealed from the atmosphere by the products of combustion with which it is surrounded.

Fig. 1 represents a furnace of this type suitable for annealing purposes, and also for the tempering and hardening of steel, case-hardening, and all such processes which require this soaking effect at any temperatures up to 1,200 deg. C. this temperature being maintained quite easily with a gas pressure of 3½ to 4 in. water gauge. It will be seen that the burners, B, are arranged in a line entering the bottom of the furnace in the centre. The whole of the secondary air being admitted through the flues, A A, and controlled by the dampers, D D, combustion takes place in the chamber, C, beneath the floor of the furnace, F, the waste gases passing into the oven itself through nostrils at the sides and finally entering the flue outlet, O. It will be observed that the secondary air flues, A, are so arranged that a considerable preheating effect is obtained; and although such a system of preheating may not be considered either as regenerative or recuperative by reason of the heat supplied to the secondary air not being abstracted directly from the waste gases, the net results obtained with such a system are, nevertheless, much the same, as a certain amount of heat is being continually transferred by means of the secondary air from the oven slab to the sides and roof, which results in very uniform heating being maintained throughout the whole of the working space.

As regards the working pressures suitable for this class of work, the results of a considerable number of experiments show that, disregarding for the moment the time taken for the preliminary heating up of the furnace, no advantage is obtained when working with pressures higher than 4 in. of water gauge. With this pressure, temperatures up to 1,200 deg. C. can be maintained. The best results are obtained when the aëration is only just sufficient to allow of the required temperature being maintained—that is to say, the volume of the flame should be a maximum for the temperature required. Furnaces of this type are particularly suitable for the annealing of brass

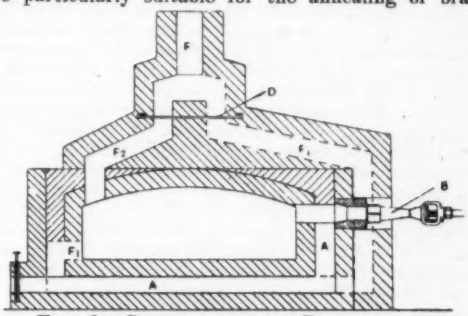


FIG. 2.—SECTION THROUGH REGENERATIVE REVERBERATORY FURNACE.

and steel stampings, where temperatures of from 800 deg. to 950 deg. C. have to be maintained; also for the case-hardening of steel, where temperatures up to 1,100 deg. C. are required. As regards case-hardening, it will be found that little or no carbon absorption will take place at temperatures below 900 deg. C.; the best results are obtained by soaking at as low a temperature as possible for a long period, rather than working at a higher temperature for a shorter period.

For normal carbon steels, it is usual to case at a temperature of about 1,050 deg. C., quench when the required depth of casing has been obtained, re-heat to a temperature of about 950 deg. C., and quench again finally in oil or water, according to the particular degree of hardness required. For the processes both of case-hardening and re-heating this type of furnace is admirably suited.

Fig. 2 represents a section through a regenerative, reverberatory furnace, suitable for use with either low-pressure or high-pressure gas, the working pressure depending on the temperature required. It will be seen that the burners, B, are placed in a line entering the side of the furnace, and so arranged that the flame impinges on the arch; the waste gases pass over the work and thence into the flue outlet, F_1, situated at the bottom on the opposite side, whence

* From a Paper entitled "Notes on Gaseous Heating," by E. W. Smith and C. M. Walter, read before the Institution of Gas Engineers.

they are conducted beneath the bed of the furnace into the main flue, F, giving up their heat to the secondary air, which passes through the flues, A, arranged alternately with the waste-gas flues beneath the furnace bed. It will be further observed that an auxiliary flue outlet, F_2 is provided. This is necessary to prevent any short-circuiting taking place when the furnace door is opened; the dampers being so arranged that when the furnace door is opened, F_1 is closed and F_2 opened simultaneously. Furnaces of this type are very suitable for any class of annealing operation where the work itself does not offer an obstruction to the flames, such as the annealing of plates or of stampings. Temperatures up to 1,500 deg. C. may be obtained with a working pressure of about 100 in. W.G. A similar design of furnace may also be adopted for the forging, welding, and hardening of high-speed steels.

When considering the mechanical design and construction of gas furnaces, the conductivity of fireclay is of extreme importance. In large muffles and ovens, in which a big body of heat is required, particular attention must be paid to the conductivity of the firebrick employed, so that the thickness of wall, to give the most economical working, may be determined. There are, of course, many factors to be taken into account when considering the question; but it will be easily understood that, in the case of small furnaces which are used only during the day, and therefore require to be heated up to a working temperature each morning, the time required for this preliminary heating up will to a great extent depend upon the thickness and conductivity of the walls. In such cases the amount of brickwork should be a minimum; a 4½-in. brick, backed up by a good non-conductive material, well cased round, preferably with wrought plate, being all that is required. The lining, however, should be as non-conductive as possible, so that the radiation losses are reduced to a minimum.

Coming to the larger furnaces of this type—say, over 3 ft. 6 in. in width—it will, in most cases, be found that, owing to the large amount of heat absorbed by the brickwork during the preliminary heating up, the more economical method of working is to arrange for a small number of burners to be kept on continuously—maintaining a temperature of not less than 600 deg. C. in the furnace during the period in which no work is being carried out. With such a system of working, there is not only a fuel economy to be obtained, but the maintenance cost will be considerably reduced. For very large muffles and ovens which are working continuously, the thickness of wall should not be less than 14 in.—9 in. at least of which should consist of best quality firebrick material. The general method of staying-up these large furnaces with buckstays and cross plates is quite satisfactory, there being no need in such cases for any metallic casing.

In dealing with the mechanical construction of melting furnaces, it is most important that provision should be made for the bottom of the furnace to be so constructed that it can be removed and re-made as expeditiously as possible, as the successful working of such furnaces depends to a great extent on the maintaining of the bottom free from spilt metal, which is not only liable to cause blocking-up of the burner passages, but also considerable damage to the furnace lining itself, owing to its fluxing effect with the firebrick. This arrangement may be very efficiently carried out by arranging for the bottom plate to be fitted with a circular cast-iron flange plate having the same diameter as the lining itself, this plate being held in position by two drawbars passing through projecting lugs cast on the underside of the bottom plate. (The furnace itself should be built on brick piers arranged at a convenient height.) On the top of this flange plate the furnace bottom is placed. This consists of a mixture of broken firebrick and ganister well rammed to a depth of 2½ to 3 in. Should the bottom be required to be renewed, all that is necessary is for the drawbars to be withdrawn and the flange plate removed. The fireclay bottom may then be dropped out with the aid of a dumping rod from the top of the furnace, and any spilt metal recovered with a minimum of trouble. To obtain the best results, it is essential that the rebottoming of all such furnaces should be carried out at least once a week.

The proper dimensioning of the lining is of the greatest importance if high temperatures, efficient working, and low metal losses are to be obtained. The diameter of the lining is generally determined from practical considerations, it being remembered that pot tongs must be accommodated. It may therefore be taken as a rule that the diameter should be sufficient to allow of a clearance of about ½-in. over the maximum dimensions of the pot tongs used, although in cases where the pots are not removed from the furnaces this figure can be reduced with advantage. In no case, however, should the dimensions given above be exceeded if the highest efficiencies are to be obtained.

The height of the furnaces is again to a certain extent determined from practical conditions, this

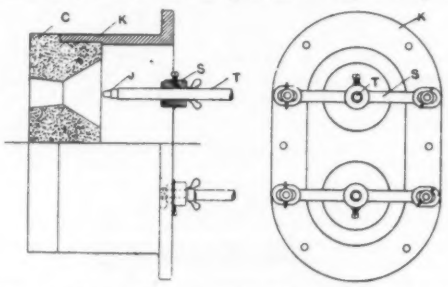


FIG. 3.—NEW PATTERN "S.-W." HIGH-PRESSURE GAS BURNER.

depending upon the nature of the metal to be charged. To obtain the minimum metal loss, however, there should be at least a depth of 6 in. above the rim of the pot in the case of furnaces up to 80 lbs. pot capacity, and of 10 in. in the case of the larger pots, the bottom of the flue outlet being slightly higher than the rim of the pot.

Burners should be arranged to enter the furnace tangentially to the annular space between the pot and the lining, and fixed on opposite sides where possible. For small melting furnaces up to 80 lbs. pot capacity a single burner will suffice. In the case of the larger sizes, however, two or more burners should be used, placed on opposite sides.

Fig. 3 represents a section through the new pattern "S.-W." duplex high-pressure burner; this having been designed to meet the requirements for the melting of nickel and high-copper alloys. K is an oval cast-iron thimble flanged to fit into cores cast in the side plates of the furnace. This thimble supports a massive duplex fireclay core brick, C, the nose of which fits into a recess moulded in the specially designed linings referred to above. The burner tubes, T, carrying the jets, J, are supported in cast-iron stirrups, S, which are bolted to the flange of the thimble; these stirrups being slotted so that the jets may be adjusted to coincide with the centre lines of the injector cones. This was found necessary to accommodate slight variations which take place in the manufacture of the clay cones.

Moulding Sands and Coal Dust.

The meeting of the Birmingham Branch of the British Foundrymen's Association, held on Saturday, December 6, under the presidency of Mr. C. Heggie, was devoted to a discussion on moulding sands, and incidentally on the varying qualities of the coal dust supplied to the foundry for moulders' use.

The discussion was opened by Mr. J. Shaw (Dudley), who said that they might take it that most ironfounders used a local sand, or one that was put into the works cheaply through special conditions. For example, Erith sand, which was used largely in the Northern foundries, was sent as ballast for returning empty ships. The first thing to do when one had trouble with sand was to obtain a complete chemical analysis. According to Longmuir, one of the worst examples of a local sand gave the following analysis :—

SiO_2	82.97	– (13.6 + 2.2) =	67.17 = Si O_2
Al_2O_3	5.07	– 3.17 = 1.90 + 2.2 + .6 =	4.7 = Clay
FE_2O_3	4.96	=	4.96 = Iron Oxides
CaO	.55		
MgO	1.17		
K_2O	2.48	4.746 + 13.6 + 3.17 =	21.516 = Felspars, etc.
Na_2O	.546		
Loss	2.000		

At this point Mr. Shaw, using in illustration a quantity of copper filings and brazing solder filings, gave a simple explanation of the manner in which the results of chemical analysis are obtained and of the manner in which compounds are formed in alloys. Then he exhibited three of the chief materials found in sands, namely, silica sand, clay (which, if pure, would contain 46 per cent SiO_2, 40 per cent. Al_2O_3, and 14 per cent. H_2O) and felspar (which might contain 64.74 per cent. SiO_2, 18.36 per cent. Al_2O_3, and 16.9 per cent. K_2O, or Na_2O). Clay was a chemical compound of silica, alumina, and water. It was not a mixture, but if he might use the term, an alloy with characteristics of its own. Felspar was also another chemical compound of SiO_2, Al_2O_3, and K_2O, or Na_2O, or both in varying proportions. The melting point of silica was 1,600 deg. C., and of felspar about 1,230 deg. C., while cast iron melted at 1,515 deg. C.

If silica, dried clay and felspar were powdered and mixed, and sent for analysis, the chemist would first use an acid which would attack everything but the silica, so that every other constituent would be dissolved, leaving the free silica and also the silica from the clay and felspar. By using other acids he would then separate all the alumina from the clay and the felspar. Now, just as copper in brazing solder, by becoming part of an alloy, had properties quite distinct from those of the pure copper, so silica and alumina had different characteristics when forming parts of different compounds. But to return to the original analysis, there were lime, magnesia, potash and soda as the fusible factors; these did not exist in the sand as potash, soda, etc., but were parts of chemical compounds. The potash, the soda, and perhaps the lime, most probably belonged to one of the felspar groups, and would thus reduce both the total silica and the alumina. The magnesia might belong to several compounds that contained silica. A microscopic examination would give a good idea of what was present. He had calculated that these fusible constituents would reduce the pure silica by 13.6 per cent. and also the alumina in the clay by 3.17 per cent., and would, of course, increase the fusible part by these amounts. This left 1.9 per cent. alumina for the clay, which took up 2.2 per cent. silica from the total silica, leaving the pure silica at 67.17 per cent. The total clay would be by the addition of 0.6 combined water brought up to 4.7 per cent., whilst the total fusible part had been brought up to 21.56 per cent., or one-fifth of the whole. It would be realised, then, what an important part small quantities of fusible constituents played, and also why a complete analysis was necessary. The sand spoken of was deficient in strength, and soon became air-dried, so that the moulder was apt to use the water brush too freely in order to get it to patch up.

The next procedure was to make a sieve test, which came out as follows :

Mesh.	Retained on Sieve. Per Cent.
30 to the inch ...	0.780
60 ,, ,, ...	4.280
90 ,, ,, ...	15.740
150 ,, ,, ...	55.560
Through 150 ,, ,, ...	22.948

It would be noticed that 78 per cent. was fine sand. Such a sand, with a fair amount of large material present, packed well, and gave a high permeability test, in fact, a much higher test than was given by a sand showing a greater average fineness. From a large number of experiments that he had made, he had come to the conclusion that the average fineness was no guide to a sand's permeability. With these three factors before them he did not thing they would have much difficulty in detecting the weak spots in their sand.

The part played by coal dust in facing sand should also be considered. Was it only used for venting purposes? Also, why would not coke dust or sawdust do, since these were both carbons? If the coal dust was necessary for giving a skin to the casting, why was the mould afterwards faced with plumbago. Another question often asked was, "What proportion of coal dust do you use?" The first thing to settle, however, was what coal dust was used. One he tried recently contained fixed carbon 51 per cent., volatile matter 30 per cent., ash 19 per cent. This might be compared with the analyses of a number of samples taken from the thick coal at his firm's No. 14 pit, two of which were as follows :—Thick coal, fixed carbon 58.25 per cent., volatile matter 39.40 per cent.; ash, 2.35 per cent. Hard coal, fixed carbon, 60 per cent.; volatile matter, 37.95; ash, 2.55. It was obvious that the dealer in the former case did not use lump coal to obtain the first analysis. Let them consider for a minute what it meant to use a coal of that analysis. Supposing one part of coal dust to eight of sand were being used, which would mean 14 lbs. of dust to a hundredweight of sand. There would be in the mixture 7 lbs. of fixed carbon, four and one-fifth pounds of volatile matter, and two and four-fifth pounds of a fritting material in its worst form, namely, an impalpable powder which would stop the venting. With coal dust from the thick coal, he thought six pounds of fixed carbon would give the same effect as would seven pounds of the first analysis, because of the low ash content. That would give them 3.79 pounds of volatile matter and only 0.2 pounds of ash, a total of 9.9 pounds against 14 pounds, or a saving of about 28 per cent.

Coming to the question of proportion of coal dust to sand, Mr. Shaw invited members to express their opinion as to which of the two castings he sketched on the board required the greater addition of coal dust, and why. The first was a trough 2 ft. 6 in. wide, 2 ft. 6 in. deep, and 6 ft. long, with 2½ in. of metal all through; the other was a plate 2 ft. square and three-eighth inches thick. With regard to the method of mixing, that depended entirely on the sand used. The fineness of the Erith sand and of two Lancashire sands compared as follows :—

	Erith. Retained on Sieve. Per Cent.	Lancashire. Per Cent.
30 Mesh Sieve ...	0.192	—
60 ,, ,, ...	0.840	12.260
90 ,, ,, ...	9.280	57.840
150 ,, ,, ...	38.876	17.140
Through 150 ,, ,, ...	58.088	8.068

For the Erith sand, simply mixing, cutting and riddling, or putting the whole through a centrifugal mixer of the "Herbert" type was all that was needed, but unless the mixing was well done first, the sand would come out of the machine in layers. The coarse sand was generally put in a mill so as to obtain a finer material. The weakness of that method was that the rolling reduced the small grains as well as the large, and unless the grinding was carefully watched it would add a large proportion of dust, and this would mean a reduction of the venting.

The addition of old sand depended on the content of clay in the new sand, the content of clay in the old sand, and the section of the casting to be made. It was quite evident that a sand like that in the first analysis would stand little addition of old sand for a green-sand casting of any weight. Therefore no fixed rule could be given without a knowledge of the material to be used. The question of the moisture content of the facing sand should receive more attention than it did in connection with machine moulding. He had taken up to the laboratory samples of facing sand which had been pronounced right by several of the best moulders in the shop, and had found the moisture vary more than 100 per cent. It was very difficult to judge by feel on a particularly dry or a particularly damp or cold day. With regard to the various "revivers" of old sand on the market, he had seen one tried some years ago which acted efficiently for some time; then everything went wrong, and the old way was reverted to. Even if the preparations at present being sold were all that they claimed to be, he did not think that they would displace new sand in that neighbourhood. The first cost of the liquid and, afterwards, the cost of getting it thoroughly mixed with the old sand, put it out of the market.

The last point raised by Mr. Shaw was the cost of facing per ton of castings made. That was a question which demanded more attention from both foreman and moulders. He thought they could take it for granted that at least an inch thickness of facing sand was needed for an average casting. One square foot of rammed facing sand one inch thick weighed 8 lbs.; therefore, if the area of the casting and the cost of their facing sand per ton were known, some idea of the cost of the facing sand per ton of castings made would be got. Some time ago he calculated for one job a stanchion with deep pockets and a large number of brackets, and it averaged 15 lbs. of facing sand per superficial foot. The casting weighed about two tons, and the facing ran out at 3s. 6d. per ton of castings.

One American firm gave a return of 4 cwts. of new sand per ton of castings. This was an average for three years. Mr. Keep's return for stove-plate work was also 4 cwts. per ton of castings made.

The PRESIDENT said it would be gathered from Mr. Shaw's remarks that chemical analysis alone did not solve the question. Rational analysis, too, had been pointed out by other experts as being unsatisfactory and unreliable. Considering this and the difficulties of their application by the average foundry manager, one supposed that empirial methods would continue for some time yet, and foundrymen would continue to judge by taking up a handful of sand, combining rule-of-thumb with a little scientific knowledge.

MR. R. BUCHANAN said that with regard to plumbago, some years ago he examined a number of samples and came to the conclusion that if one knew the price one had some idea of the adulteration. The man who thought he was going to get either plumbago or coal dust at runaway prices and get it pure and good was only deceiving himself. The point brought out as to the real comparative value of the two coal dusts of which the analyses were given was very important. With regard to the function of coal dust in facing sand, there was at one time some doubt in his mind as to whether the coal dust was simply a material for skinning the casting, or helped at the same time to vent the sand. He once asked some of his best moulders whether the coal dust served to vent the sand as well as to skin the casting, and they were unanimous that it did open the sand and give freer passage to the gases. He asked them how it was, seeing that the coal dust was distilled by the heat of the casting, that the gas from the coal dust and that from the metal did not combine to choke the passages. It was a debatable point, but his own skilled moulders were decidedly of opinion that the coal dust opened the sand as well as skinned the casting. There was no doubt that it was the volatile matter in the coal dust which had the true skinning effect on the casting. He made some tests to settle the matter. He had ground some anthracite and mixed it in some facing sand, and without saying anything gave the facing to one of his best men, who was rather surprised to find that the casting not only scabbed, but also had not the same appearance as when facing sand with coal dust from bituminous coal was used. Carrying the investigation further, he took two small pieces of cast iron, and made them perfectly bright. Into one crucible he put some ordinary coal dust containing 30 or 40 per cent. of volatile matter, and into another some anthracite coal dust. The pieces of bright iron formed the lids, but were not in contact with the coal dust. Then he put the two small crucibles into a larger crucible, and that into the muffle. The result, he thought, showed that it was the volatile matter which skinned the casting. The piece of bright iron which was over the ordinary coal dust came out with a beautiful blue skin; the piece which had been over the anthracite showed practically no change in colour. As to the question of bond, that very week he was asked about a moulding sand with which was being experienced considerable "drawing down" of the top part, the castings coming out rough. The sand had practically no bond at all; it was over-saturated with water, and he found that about two parts of burnt sand from the foundry floor to one part of new sand were being used, with the result that the quality of the sand had at length deteriorated to practically the lowest point. That was not at all an uncommon cause of trouble, and such an experience proved that one could be too economical in regard to buying new sand. One could revive sand in various ways. One founder used crude sugar, and had thus been able to do without new sand for two or three years. But, as Mr. Shaw had pointed out, one had to consider the local conditions when taking into account whether it would pay or not to use a reviver. He quite

agreed that in the Birmingham district it would not pay. In respect of fusibility, there was a great deal of difference among sands. The Glasgow "rotten rocks," as they were called, made very beautiful castings, and were generally used in the Glasgow district; yet for green-sand work this material had to be thickly coated with blacking, which had to be slicked on to the mould so that it might retain its place against the wash of the metal. If this were not done fusion took place and the casting came out very rough. The red Wolverhampton sand gave beautiful castings without having any blacking. He admitted that there were fairly large percentages of coal dust used, but neither plumbago nor blacking was required. In that case one spent a little more money in extra coal dust, but saved it in the plumbago or blacking, as well as in the time required for slicking on. He was told that the amount of Erith sand used in the North of England was very great, but he understood that a very much bigger proportion of old sand could be used with the Glasgow sand than with the Erith sand. With regard to a loam mixture which Mr. Shaw told them worked out at 6s. 10d. per ton, was that per ton of loam or per ton of castings produced? (Mr. Shaw: Per ton of loam.) In the North of England they made a good deal of loam with Erith sand, but its bond was so doubtful that in most places they used hair, such as was used by plasterers, to tie it together. This hair was rather an expensive material, and would rather put up the price of Mr. Shaw's loam mixture. Fortunately, in the Birmingham district it was not necessary to use hair in loam.

Mr. H. Winterton, dealing specially with the question of coal dust and facing, said he found on reference to the remarks of various speakers and writers of eminence in the trade, a wonderful divergence of opinion as to the value or otherwise of the various fundamental characteristics of foundry sand. One authority on the subject declared that the porosity of a moulding sand was one of its most important qualities, whilst another eminent metallurgist said with equal emphasis that the porosity of a moulding sand was of smaller importance than was generally supposed. With such disagreement among authorities it could easily be understood that the subject was one full of pitfalls for the unwary, and at the same time a matter for prolonged and exhaustive discussion. With regard to coal dust, it was a long time since he had come across a coal dust showing so low a percentage of ash as 2.3 per cent. For any coal dust with such an anaylsis there ought to be a big demand among foundrymen. But the 19 per cent. ash mentioned in the other analysis was very high. Among the various coals which had been submitted to him from different districts as eminently suited for foundry purposes, the analyses had shown ash as high as 34.06 per cent., and some as low as 3.50 per cent. The volatile matter ranged from 35.75 per cent. to 27.60 per cent., the fixed carbon from 54.93 per cent. to 36.57 per cent., and the water from 1.30 per cent. to 6.45 per cent. With regard to the functions exercised through the mixing of coal dust with the sand, there was as wide a divergence of opinion as there was between the figures he had just given. On the one hand there were writers who maintained that coal dust was used to make porous sand "fat," that it burned out and allowed the gases to escape, and that if poor quality or insufficient quantity were used blow-holes would be formed. Others, equally practical, and equally eminent as theorists, maintained that coal dust was mixed with facing sand in order that there should be a good "strip," and that the casting should have a good skin, caused by the dust in contact with the molten iron creating a gas and forming a film which prevented the iron fusing the silicates. Hence, it was said, the clean bluish skin. But, whatever the effect, all writers on the subject seemed to have arrived at the conclusion that the quality of the coal dust mixed with the sand should be carefully maintained at an even standard from time to time and that many of the troubles with which the moulder was faced were due to variations in this respect. An even standard of quality was necessary in order that the same quantity might be mixed with the sand from day to day. Of course, where the sizes of the castings varied, different proportions of sand and coal dust should be used. That brought him to the question of whether a large quantity should be used in making big castings and a smaller quantity with smaller castings.. This was a question which he would leave to others, but he thought as a general rule, such a variation in quantity should be observed. In time past the question of coal dust was looked upon as comparatively a minor item in the foundry, but he believed the time was coming when no firm would be satisfied with anything simply because it was cheap, but would demand a certain quality week by week.

The President remarked that with regard to the functions of coal dust, he thought it was agreed that the gas generated by the hot metal prevented it penetrating the mould and also retarded the fusion of the sand. As to the importance of porosity, he agreed that porosity, as such, could be left out of consideration all together, its real value lying, of course, in its relation to permeability. Permeability was porosity plus something else, and this property in a mould was responsible for the easy escape or otherwise, of the gases generated; it also had some relation, he thought, to the penetration of the mould by the metal. Some years ago Dr. P. Longmuir, speaking on this, pointed out that a mould giving good results with cast iron at ordinary casting temperature, would, of course, be fused and particles that could not be brushed off would adhere to the casting. That was a temperature effect only, but again, if lead was used and poured, say at 400 deg. C., the result might be satisfactory, while another casting poured at, say, 600 deg. C. would have every appearance of the sand having been fused, although the temperature was so much lower than that of cast iron.

Mr. W. B. Parker (Rugby) considered that the gas from the coal dust formed a film which tended to keep the metal from contact with the mould. Coal carbonised at a temperature of 750 deg. C., while the melting point of iron was about 1,500 deg. This film also prevented the penetration of the metal into the sand, and if the coal dust contained plenty of volatile matter the effects lasted for a long time. But if the coal dust was of very poor quality the effect was over almost instantaneously, and the metal tended to penetrate, as it remained liquid for some time after the film effect had ceased. He agreed that there were great differences in analysis between various coal dusts. There was also much variation of quality in plumbagos. A new sample of plumbago just used in their foundry on analysis was shown to contain 85 per cent. of graphite, whereas the stuff they had been using contained only 55 per cent, the balance in each case being ash. The new plumbago was 20 per cent. cheaper than the old, so that they gained both in price and quality. The reason why the inferior plumbago had been preferred was that it had been more cunningly ground so as to exhibit the flaky appearance common to natural graphite. The preference for it, therefore, was purely a matter of prejudice. The comparison used by Mr. Shaw between the alloys of metals and the original

rocks forming two sources of sand was an excellent one. All the sources of sand had been originally igneous rocks; the rocks had been in an actual state of fusion, and as they cooled down had separated out into constituents just the same as did brass. Take a 55 : 45 brass; in certain circumstances this in cooling would separate out, forming an alpha constituent, which was the greater part, and a beta constituent. In just the same way the felspar separated out in crystals, and also mica flakes and other crystalline constituents. The quality of the sand naturally depended on the character of the igneous rock from which it was formed. An igneous rock which cooled very slowly, and therefore formed large crystals gave a poor sand. With regard to moisture in sand, at their factory they had a big grinding plant, and after the sand had been ground the superfluous moisture was dried out, and then a definite amount added again. One factor which controlled the amount of moisture to be allowed was the handling of the sand in the bins. If they had the sand too moist it would not pour down the chute; if they had it too dry it was of no good in the mould. They had determined by a series of analyses that 7 per cent. of moisture was the best proportion for each purpose, for moulding and handling. With regard to moulding sands, the only features they usually determined were the size and form of the grain, whether the grains were rounded or broken. From that they could more or less judge the treatment to be given to the sand. After it had been mixed there were only three points to be determined as far as they were concerned. The total loss by ignition would, of course, represent the volatile constituents of the coal dust and any manure or anything of that kind. Then there was the moisture; they dried the mixture at 110 deg. C., and what remained was what they called the ash, and that roughly represented the sand in the mixture, and the ratio of these things to one another was really sufficient to control their moulding work, provided they already had the right sand to put in.

The PRESIDENT, referring to the question of the sand grains, said that that was a point more readily appreciated by the ordinary moulder or foundry manager. With a fairly good microscope one could ascertain the size and shape of the grains and that affected not only fineness, but every other necessary property of the sand as well.

MR. D. DALRYMPLE (West Bromwich), referring to the mixture of sands for facing, said that a great deal depended on the class of casting. For very light and medium-heavy castings the best mixture was three parts of new sand and three parts of old sand which had been used for moulding. For the finer and extremely light castings they used also the surplus from the shops and the core sand. The materials were all ground together with one part of coal dust of good quality. With such a mixture they got very good results. After several tests, including a three months' test and a six months' test, the cost worked out at 1s. 3¼d. per ton of castings made, but that was only for the sand. If he took into account the coal dust, that would make the total about 2s. 2½d. per ton of castings produced. Of course, this was with very light castings. With heavier castings a great deal more coal dust should be used, and this would greatly increase the cost. But with that mixture for facing sand he never used any blacking; with good coal dust and a good mixture blacking was not required. He used Wombourne sand.

MR. S. W. B. STEPHEN (Smethwick) said that with ordinary thick coal one could get ash as low as 2.35, as Mr. Shaw had done, but that was with pure lump coal, not with slack. To buy coal dust containing such large amounts of ash as had been mentioned was absolute foolishness, but he was sorry to say that false economy of that kind had entered into the matter of foundry supplies.

MR. PARKER said that one of the largest steel works in the North of England was getting sand from Belgium because it was so much superior in quality to any that they could get in England. The superiority of the Belgian sand was not due altogether to any geological cause, but was partly the result of the extra care taken in mixing. The importance of this point had been recognised in this country, and certain English firms were laying down plant identical with the Belgian plant in order to get the same quality of mixture.

MR. J. BULLOCK (Smethwick) said that at one place they had a large quantity of castings streaked very bodly; was that through bad coal dust?

MR. J. MATTHEWS (Walsall) agreed with Mr. Parker that when coal dust was mixed with the sand a film of gas was formed due to the burning of the coal dust, which, for the time being, prevented the metal coming in direct contact with the mould; the coal dust, of course, making the sand more porous and thus allowing the gas generated to escape freely from the mould. He considered it would be wise to put more coal dust in the sand for larger castings than for smaller ones.

MR. H. WINTERTON, referring to the grinding of plumbago, explained that there were two kinds of machines in use. One had a hammering action and the other ground the material as a chemist ground with pestle and mortar. He remembered going to see a machine which was specially recommended to his firm for grinding plumbago, and they tried one. They put in some perfectly clear plumbago which looked like silver and glistened perfectly in the sunshine when it was put into the machine, but it came out as dead as ditchwater, simply because it was not ground in the customary way. This plumbago contained about 91 per cent. of pure carbon, but it came out looking like ash.

MR. SHAW, replying, said that he did not think that the hair used with the Erith sand had anything to do with the binding qualities. The sand was a very fine sand, and they could get any amount of clay in it, and he believed the hair was put in simply for venting purposes, though, of course, it did bind to some extent. He did not think they needed to enter into the question of porosity. Common-sense would tell them that it did not matter. They might have pores in any number and yet the gas might not pass through easily. Of course, porosity did give to some extent a degree of permeability, but two sands equally fine might not allow the gas to pass through to the same extent. He thought it was pretty generally agreed now that the coal dust caused the skin on the casting; and there was no doubt that coal dust also aided the venting. He had had letters from ten or a dozen leading members of the Association who agreed that it skinned the casting, but they were not all quite sure about the venting. If two cones were placed in a furnace, one of sand with coal dust and one of sand only, it took a higher temperature and longer time to frit or glaze the former than the latter. Chemical analysis was of great importance, but to be of any service should be complete, giving the alkalies. Mr Dalrymple had not allowed anything for labour, depreciation of plant or power in his estimate of cost of facing sand; add these and his figures would be about the same as his (the speaker's). He did not expect to obtain coal dust with only 2.3 per cent. ash, but the ash content gave an idea of the material the coal dust was being ground from; 3 or 4 per cent. was possible from lump coal.

Melting Points of Copper Alloys.

By H. W. Gillett and A. B. Norton.

The United States Bureau of Mines has undertaken an investigation of the non-ferrous-alloy industry in the United States with especial reference to the development of more efficient methods of melting brass and other alloys and the saving of metal losses; and in the course of the study of metal losses, and the possible development of more efficient types of melting furnaces, it became necessary to determine with approximate exactness the relation between the pouring temperatures and melting points of various copper alloys.

The alloys were melted in a gas furnace. Instead of crucibles of the ordinary shape, which exposes too large a surface to volatilisation and oxidation, the crucibles used were made from some bonded carborundum tubes that were in stock from a previous investigation. The carborundum tubes were about 4.5 cm. inside diameter, and had walls about 8 mm. thick. They were cut to about 15 cm. long and a plug of artificial graphite was fitted at one end to form the bottom and luted in place with alundum cement.

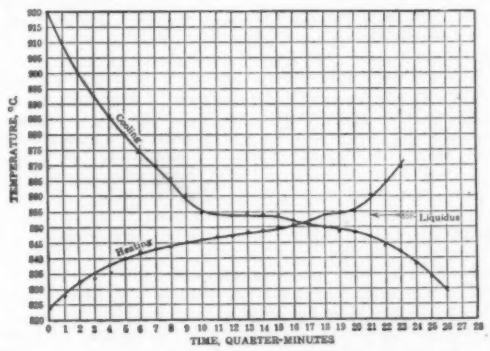


FIG. 1.—FREEZING AND HEATING CURVES OF NAVAL BRASS (61.7 CU.; 36.9 ZN.; 1.4 SN.).

The temperatures were measured by a platinum, platinum-rhodium thermocouple used with a single-pivot galvanometer. The thermocouple wires were insulated by Marquardt tubing of 1 mm. bore and 2 mm. outside diameter, and the hot junction was slipped into a Marquardt tube 30 cm. long, of 9 mm. outside diameter and 5 mm. inside diameter, that was closed at one end. The open end of this tube was fastened, with alundum cement, into an open-ended porcelain tube 35 cm. long, and of 10 mm. inside diameter and 14 mm. outside diameter. This arrangement served to protect the couple from zinc fumes or reducing gases. The end of the protecting tube was in turn protected from the molten metal by an artificial graphite boot 9 cm. long, with walls 3 mm. thick.

There is a considerable time lag in a pyrometer reading when a cold protecting tube and boot are plunged into molten metal, but after the tube is once hot the lag is small. As the melting points were not determined by noting when the metal solidified, but by plotting temperatures against time, the proper temperatures for the heat evolution on freezing or heat absorption on melting should be shown even if there was some lag.

About 600 grammes of metal was used in making the tests. The metals were weighed in the proper proportions to form the alloy desired, a slight excess of zinc, increased with increasing zinc content, being allowed to compensate for volatilisation. Electrolytic copper, Bertha zinc, and chemically pure lead and tin were used. The copper was melted first, and then covered with granular carbon and a little salt. When the copper was melted the tin, the lead, and lastly, the zinc were added, and the alloy was well stirred with a graphite rod.

When the alloy was fully melted and mixed the pyrometer was inserted and so clamped that the graphite boot did not touch the bottom or sides of the crucible. The gas flame was lowered and the temperature read every 15 seconds, the melt being stirred between each reading. When the alloy had frozen, the gas was turned up and a heating curve was taken. This procedure was repeated several times. Zinc was continually volatilised from the melts containing zinc, but not in sufficient quantity to have appreciable effect on the melting point, as duplicate runs agreed within 5 deg. C. in all cases. After a run was completed, the melt was usually poured into an ingot mould, sampled, and analysed. As the analyses of the samples analysed agreed well with the composition desired, the melts containing zinc were not analysed. Duplicate analyses of the same sample agreed within 0.1 per cent.

All the melts were made from virgin metals except a sample of manganese bronze which was in the form of test-bar ends from a previous investigation. It had shown a tensile strength of 76,000 to 77,000 lbs. per sq. in., and an elongation of 24 to 35 per cent. in the standard brick-form test bar. The bronze had approximately the following composition:—Copper, 56 per cent.; zinc, 41 per cent.; iron, 1.5 per cent.; tin, 0.9 per cent.; aluminium, 0.45 per cent.; and manganese, 0.15 per cent. As the bronze was first cast into an ingot, then remelted and cast into test bars, and these again remelted for melting-point determination, the zinc content was probably nearer 40 than 41 per cent., and the copper content nearer 57 than 56 per cent. when the melting points were taken. This sample was not analysed.

The melting point given is the liquidus, or point at which freezing begins on cooling and liquefaction ends on heating. This is more strongly marked than the solidus, or point at which freezing ends on cooling and liquefaction begins on heating. Fig. 1 shows one set of curves and the characteristic break at the melting point (liquidus). These curves are typical of all melting-point determinations.

The data obtained in the determination of the melting points of several alloys were as follows:—

	Composition Aimed at				Composition by Analysis.				Melting Point (Liquidus)	
	Cu	Zn	Sn	Pb	Cu	Zn	Sn	Pb	C	F
Gunmetal ..	88	2	10	—	—	—	—	—	995	1825
Leaded gunmetal	85½	2	9½	3	85.4	1.9	9.7	3.0	980	1795
Red brass ..	85	5	5	5	—	—	(2samples)		970	1780
Low-grade red brass	82	10	3	5	81.5	10.4	3.1	5.0	980	1795
Leaded bronze ..	80	—	10	10	—	—	—	—	945	1735
Bronze with zinc	85	5	10	—	84.6	5.0	10.4	—	980	1795
Half yellow, half red	75	20	2	3	75.0	20.0	2.0	3.0	920	1690
Cast yellow brass	67	31	—	2	66.9	30.8	—	2.3	895	1645
Naval brass ..	61½	37	1½	—	61.7	36.9	1.4	—	855	1570
Manganese bronze	—	—	—	—	—	—	—	—	870	1600

As the results all checked within 5 deg. C., an allowance of ± 10 deg. C., or ± 20 deg. F., is probably ample to cover all errors in reading, calibrating and using the pyrometer.

For comparison, the melting-point (liquidus) figures for binary systems of copper-tin, copper-zinc, and copper-lead alloys (determined by previous investigators) for the range covering the common industrial alloys are given below. These are scaled from curves by the respective experimenters. As the curves are small, the figures are only accurate within about ± 10 deg. C. or ± 20 deg. F.

Melting Points of Binary Alloys.
Copper-Tin Alloys.

Parts by weight.		Melting point.	
Copper.	Tin.	Deg. C.	Deg. F.
95	5	1,050	1,920
90	10	1,005	1,840
85	15	960	1,760
80	20	890	1,635

Copper-Zinc Alloys.

Copper.	Zinc.	Deg. C.	Deg. F.
95	5	1,070	1,960
90	10	1,055	1,930
85	15	1,025	1,880
80	20	1,000	1,830
75	25	980	1,795
70	30	940	1,725
65	35	915	1,660
60	40	890	1,635

Copper-Lead Alloys.

Copper.	Lead.	Deg. C.	Deg F.
95	5	1,065	1,950
90	10	1,050	1,920
85	15	1,035	1,895

Although the melting points of only 11 alloys were determined, the alloys chosen represent a large proportion of the non-ferrous alloys in use in the ordinary foundry. The composition of many of the other common alloys is near enough to these or to the binary alloys whose melting points are given to allow the melting point being obtained by interpolation closely enough for most technical purposes.

Green-Sand Coremaking.

By V. D.

This part of the moulder's art seems to the writer to scarcely receive the attention warranted by its cheapness and the facility with which it helps the work through. The extra care involved in handling green-sand cores, compared to that required for dry-sand, is the important reason; yet the time saved in every subsequent stage and the better results obtained more than compensate for the greater difficulty at the outset.

Suppose a core-box or core-boxes together with the pattern have been made and sent down to the foundry from the pattern-shop, and without any further interest, or very little, on the pattern-maker's part, are handed over to a moulder to produce the casting required. He looks at the core-box for the intricate parts, passes them on to the core-maker with certain instructions respecting vents, and notes that he will want certain cores, probably plain ones, either round or square section, which are made by the core-makers out of standard boxes. Having settled these matters, he proceeds with the making of the mould. It is at this stage of ordering his cores that a sharp and skilful moulder will often save himself time and trouble by considering how far he can make his cores of green-sand instead of dry-sand.

Suppose, for the sake of illustrating the point, we follow the various stages of a dry-sand core, say, 4 in. diameter 9 in. long, also a green-sand one of the same size. (It must not be forgotten, of course, that it is not always possible to use a green-sand core in place of a dry-sand core, but it is very evident to those who watch closely the various jobs going through the foundry, that green-sand core-making is much neglected.) A dry-sand core requires special sand, riddled and mixed with other materials, and as regards expense is of more value and costly than facing-sand. The one we are dealing with will require a vent hole, which must be carefully made, and it will probably have to be made with an iron to take stress and strain and also to assist in handling while "wet" in its carriage towards the stove to be dried. Some little time will elapse, after which it receives a coat of wet blacking and again requires careful handling to avoid any corners or edges breaking off. It is during this process of blacking that more accidents happen to cores than at any other time.

During the time taken up by these various stages of preparing the core, the mould has in all probability been made. If the core is dry enough, then the moulder can go straight on and prepare the mould ready for casting. If not dry enough he must leave his job quite unprepared for the cast, bottom part quite open, top part laid on one side near by, liable to all the incidental happenings and accidents of an exposed mould, while he is engaged on another, or a similar job a yard or so away. As the time for "metal down" draws near, he begins to find himself between the two jobs pushed for time; probably his second one requires no core, therefore he can go straight on and "close" it, by bushing his runner and risers, weighting and cramping, as the case may be, and then turn his attention to the job with the core.

The probabilities are that after a run to the stove for his core, it is quite dry, but too hot to handle with his bare hands, and he is compelled to use hand-cloths, which are not conducive to speed, hamper him in getting it fixed, and retard his "closing up" and other preparations towards casting.

A green-sand core of the same size would be made by the moulder himself near his job, using a riddle full of sieved sand off the floor of the foundry, otherwise called green-sand, a broad piece of flat iron a little longer than the required length of core, well clay-washed and placed as near the bottom side of core-box as practical, the rougher the iron the better. The sieved sand as above should be fairly well rammed in the box, well vented with a good needle wire at each end, and rapped lightly, and the core can be lifted out of the box by taking hold of each end of the iron, and can straightway be placed, with a little judicious handling, in its position in the mould. If the first attempt is a failure to "place" correctly, so little time is required to make another that it still is to the advantage of the moulder to do so.

Such cores require no wet blacking, only a little dusted on from the blacking bag; they are easily knocked out of the casting when in the fettler's hands; in fact, they invariably fall out before they reach him. A dry-sand core more often than not has to be "fettled" out with chisel or bar, while a green-sand core will fall out, if the casting is only knocked against a similar casting a few times,

Cast Iron for Machine-Tool Parts.

In a Paper recently presented before the American Society of Mechanical Engineers, Mr. Henry M. Wood gives some particulars of the practices of representative machine-tool manufacturers in the United States. The writer asked a number of makers in different lines and in different sections of the country if they would be willing to submit an outline of their practice. The following excerpts pertaining to the mixtures used and chemical analyses of the castings are quoted from their replies:—

A Builder of Special Machine Tools.—Our iron is bought on analysis specifications, covering two grades as follows:—

(*a*).

Silicon	1.75 to 2.25
Manganese	0.60 to 0.90
Phosphorus	0.50 to 0.80
Sulphur	0.05 & under.

(*b*).

Silicon	1.00 to 1.50
Manganese	0.50 & over.
Phosphorus	0.50 to 0.80
Sulphur	0.07 & under.

In addition to the above we use materials as follows:—No. 1 machinery scrap, mild-steel scrap, manganese-steel scrap. The last carries 12 per cent. of manganese with quantities of the other elements so small that they are negligible in grey-iron foundry work. In general practice we use three different mixtures suited to our varying needs. In our first mixture we include our lighter castings such as pulleys, small gears, washers, hand-wheels, brackets, and the like. In this mixture we endeavour to have the following analysis:—

Silicon	1.90
Manganese	0.60
Phosphorus	0.70
Sulphur	0.08

This is usually secured by the use of a mixture of 50 per cent. of two or three lots of (*a*) iron and 50 per cent. of scrap. The proportions of the different pig-irons are adjusted to produce the proper analysis in the mixture, and the scrap is partly our own foundry return and the balance No. 1 machinery scrap.

Our second mixture covers all our heavy work, such as planer beds, posts, tables, face plates, frames, etc. These castings require strength and sufficient density to permit the machined surface to take a high polish. The analysis is as follows:—

Silicon	1.40
Manganese	0.60
Phosphorus	0.60
Sulphur	0.09

This mixture consists of 45 per cent. of two or more (*b*) irons and 55 per cent. total scrap, shop and No. 1 machinery together. Should this mixture fail to yield sufficient manganese, the addition of 1 to 2 per cent. of manganese steel scrap is made to correct it. The third mixture is "semi-steel," used principally for large blank gears and castings requiring special strength. Its analysis is:—

Silicon	1.20
Manganese	0.90
Phosphorus	0.45
Sulphur	0.09

Its average make-up is:—Machinery scrap, 30 per cent.; mild-steel scrap, 20 per cent.; manganese-steel scrap, 5 per cent.; (*b*) pig-iron, 45 per cent.

A Manufacturer of Precision Machinery.—In our work we run various grades of iron to meet the conditions existing in the machines or in the parts of machines under consideration. In a general way our mixtures, in per cent., run as follows:—

Silicon.	Manganese.	Phosphorus.
3.00	0.60	0.80
2.40	0.65	0.70
2.00	0.65	0.60

The first is for the average run of castings of smaller size, the second for the larger castings. Where we need a special close-grain iron we use the third mixture.

A Manufacturer of Milling Machines.—We have never carried on any extensive experiments to learn the best mixtures of cast iron for our purposes. We use in the tables, knees, saddles and vises about 20 per cent. of steel with a view to obtaining a close-grain casting, and increasing somewhat its strength. We use practically no cast iron for gears or small parts, these being made of steel drop-forged in the case of large parts, and also in the case of smaller parts when not adopted for manufacture from the bar.

The subject of grey-iron castings is, we believe, one of the most annoying to be found in connection with the manufacture of machine tools. Customers are not satisfied to accept machines with defective castings even though the deficiency is of such a nature as to in no way impair the life or efficiency of the machine.

A Manufacturer of Heavy Lathes.—With the heavier castings we are using a semi-steel mixture with about 20 per cent. of steel. The analysis of this iron shows 1.60 to 1.70 silicon, 0.65 to 0.75 manganese, 0.40 phosphorus, 0.8 to 0.10 sulphur. While our carbons are not noted as a rule, we get a check on these every once in a while, showing the total carbons about 3.50 to 3.60. Our iron for smaller pieces runs from 1.80 to 1.90 in silicon, 0.40 to 0.50 in phosphorus, 0.65 to 0.70 manganese, 0.07 to 0.10 in sulphur. The total carbon shows up practically the same in both mixtures. Our test bars on the first mixture break at from 2,800 to 3,200 and on the latter mixtures at about 2,600. This refers to 1 in. by 1 in. standard bars supported on 12 in. centres.

A Manufacturer of Grinding Machines.—We use castings with various proportions of steel, according to the size of the casting and the place where it is to be used, so that to-day we have very bright, lustrous surfaces, and it is possible to get accurate alignment.

Chilling Castings.

A Manufacturer of Heavy Machine Tools.—For quite a period, about nine or ten years ago, we chilled the ways on our lathes and also the rails on our boring mills. We found, however, after they had been out some time that there was trouble with the chilled surfaces scratching. It was hard for us to find exactly what was the root of the trouble and we finally gave it up.

A Manufacturer of Grinding Machines.—The main reason for chilling the different parts of our work is to increase the wearing durability and at the same time get the advantage of refining the metal and a clean surface. The parts chilled are the guides of the carriage and the surface of the table upon which

the head and tailstocks are mounted. Our method of chilling is to place plates of ⅝ in. in thickness in the mould, and these give a depth of chill of about ½ in. and a degree of hardness just to the point of where the machining can be readily done. The chilled surfaces are very much more durable than metal in the ordinary condition, and we believe by the chilling process the durability of the surface upon which wear comes is increased at least from 300 to 400 per cent.

A Builder of Heavy Machine Tools.—In 1888 we began the practice of solidifying cast-iron surfaces by introducing chill blocks in the moulds, and we have continued the practice ever since. We have not found any increase in internal strains due to the use of chills. On the contrary, when chills are properly placed they equalise the cooling of the heavy parts adjacent to lighter portions and reduce the internal stresses which would naturally result from the difference in time of cooling. If the chills are improperly used it would be possible, especially in thin castings, to cool the entire mass too rapidly and produce internal stresses.

A Boring Mill Manufacturer.—We are chilling certain surfaces on our boring-mill spindles with good results, but have found no occasion for chilling any other surfaces. If we experienced difficulty due to undue wear on sliding surfaces, we would increase the area of the surfaces and supply better lubrication and protection from dirt rather than to try to chill the surfaces of these parts. The chills serve two purposes; first, by securing closer grained metal; second, by improving the quality of the wearing surfaces. We found that it was difficult to get good castings of these spindles until we did use chills.

Chilled Lathe Beds.

In view of the considerable differences in opinions of the value of chilled surfaces and the idea held by some that it is impossible to chill an iron of high tensile strength without making it so hard it cannot be machined, the practice of the Lodge & Shipley Machine Tool Company, with which the writer is connected, is here outlined. Three average analyses are as follows:—

Silicon.	Sulphur.	Phosphorus.	Manganese.	Tensile strength.
2.16	0.065	1.01	0.40	22,310
2.17	0.065	1.01	0.39	24,840
2.45	0.076	0.63	0.71	24,195

The first analysis is of a specimen taken from the first iron run in a heat; the second from the last iron of the same heat; the third, from the average iron of another heat. This same iron is used for lathe beds of which the ways are chilled, also for other cast-iron parts which do not require the high tensile strength of "semi-steel." For some parts, such as compound rest top slides and reverse plates, we use "semi-steel." Parts subject to greater stresses or to severe shock are made of steel.

Scleroscope tests indicate that the chilled ways are twice as hard as the unchilled. The same is also shown by the planing speed, as we can only plane the chilled beds at a trifle less than half the cutting speed formerly used. In addition to the advantage gained by the hardness, the chilled beds are if anything more uniform than the unchilled. The rough beds as received from the foundry are quite straight, so that the amount of metal removed along the ways in planing is as nearly uniform as is practicable. Fewer castings are unsound than before chills were used.

The chilled surface is produced by a series of cast-iron chill plates each about 6 in. long placed end to end in the mould. The use of separate short plates eliminates much of the warping and twisting which would occur in a long chill plate. If a thick chill plate is used with a low-silicon iron, the surface of the casting is chilled so hard that it cannot be machined. The desired result is attained by regulating the thickness of the chill plate to suit the size of the casting for which it is used; then a low-silicon iron of high tensile strength can be successfully poured. The heavier the casting, the thicker the chill plate. When the molten iron strikes the cold plate it is chilled and hardened; then the heat in the mass of iron forming the body of the bed casting gradually warms the chilled surface and the chill plate, thus annealing the casting or "drawing the chill." This annealing of the chilled surface of the casting produces the desired form of hard, close-grained grey iron.

The advantages of chilled wearing surfaces for machine tools are:—

(*a*) Much harder surfaces, which experience has proved are vastly more durable than similar unchilled surfaces.

(*b*) A hard guiding surface with a relatively soft carriage, bringing the bulk of the wear on the carriage and thus maintaining the alignment of the guide.

(*c*) A denser and much more closely grained surface of the casting, giving better appearance.

(*d*) An exceptionally smooth finished surface, in which there are no pores where dirt and grit may become imbedded to cause rapid abrasion of the other bearing surface.

Electric Steel as a Commercial Product.

The Illinois Steel Company, Chicago, which for some time has had in operation an electric refining furnace of the Héroult type, gives the following as among the grades of alloy steel that have been successfully produced:—Medium nickel chromium steel, containing from 1.50 to 2 per cent. nickel and from 0.75 to 1.25 per cent. chomium. High nickel chromium steel, containing from 3.25 to 3.75 per cent. nickel and from 1.25 to 1.75 per cent. chromium. Low nickel chromium steel, containing 1 to 1.50 per cent. nickel and from 0.30 to 0.70 per cent. chromium. Nickel steel, containing 3.25 to 3.75 per cent. nickel. The carbon content in all of these grades may range from 0.15 to 0.45 per cent., or higher, as desired by the user. The use of electric steel embraces practically the entire range of steel consumption where durability and resistance to wear and shock are essential features.

British Foundrymen's Association.

Newcastle-on-Tyne District Branch.—The following officers for the year 1913-14 were elected at the annual meeting of this Branch of the Association:—President, R. Wallis (Wallsend); Vice-President, J. Weir (South Shields); Hon. Secretary, H. A. J. Bang (Edwalton House, Cleveland Road, North Shields); Members of Council: Messrs. J. C. Carmichael (South Shields); J. W. Paulin (Walkergate); J. C. Horsley (North Shields); J. J. Collin (Sunderland); A. Morris (Sunderland); H. Ford (Gateshead); J. Mathews (Wallsend), W. Henderson (Heaton); J. W. Newton (Darlington); J. Smith (South Shields); E. Smith (South Shields); R. R. Denton (Blaydon); M. E. Gallon (Dunston); and T. G. Jones (Middlesbrough).

The Making of a Foundryman.

In the course of an address before the Lancashire Branch of the British Foundrymen's Association, Mr. W. H. Sherburn, discussing this subject said:—

Many of the plans for improvement in the training of apprentices, while admirable in the abstract, leave out of calculation the most important factor, viz., the personality and inclination of the youth under consideration. However worthy the scheme laid down, little good will be done or progress made, unless the mind of the student is captured. The main complaint of the technical school and educational authorities is the lack of students, at any rate of students with any real desire for the teaching available. It would seem that the first necessity is the creation of desire in the minds of the very young and an earlier discrimination by those in charge as to their bent and capacity.

After outlining the desirable futures in early training in the Elementary School, the speaker continued:—

The course of training which I should suggest for a boy after leaving school at the age of 14 with the average elementary education, on entering the foundry, is on the following lines, taking (1) the moulding shop, and (2) the pattern shop or drawing office.

Moulding-Shop Training.

On entering the moulding shop he should be placed with a competent workman for, say, two years, not to be his labourer, but to wait on him and learn the practical use of the tools and materials. The man should feel in honour bound to give the boy opportunity. During this time the boy should be learning the elementary principles of the physical sciences of sound, light and heat and the elementary mechanical movements. He should, of course, keep in practice with freehand drawing, which he should have already commenced in the elementary school. On the importance of this latter subject I hold a very decided conviction that it should be (and eventually will be) quite as commonly taught as writing and reading. Drawing is a universal language, read alike by all nations. The teaching of the elements of the sciences just mentioned should be done in a bright, graphic way, and not in the dry text-book style of past time. When these elementary laws get embedded into the minds of youths, their application to industry will come out again as second nature; every problem will be met with those laws in view.

While, for some reasons, and in some branches of foundry work, it might be well for the youth to remain attached to a craftsman, yet under modern systems of working, and in certain branches of foundry work, he early gets (and generally jumps at) the opportunity of working "on his own" amongst a large group of similar youths with a man in charge of the lot. Under these conditions little more will be learned than is just necessary to get through the particular job in hand, and so, when adult age is reached, the man can in no sense be termed a craftsman, but is often little more than a labourer. Not more than a dozen youths should be placed under one man's care, and for a similar reason no more apprentices should be employed than the craft is able to maintain as adult craftsmen.

Specialisation in manufacture now being an established law, the opportunity of practical education outside the narrow groove in which the apprentice falls becomes less and less. To counteract this, at least one half day per week should be devoted to providing the opportunity thus lost. Much irresponsible theorising has been indulged in by those outside works management, on the subject of works classes. Attractive plans have been laid out (on paper) which have little chance of materialising. Manufacturing is becoming more and more a continuous process in which breaks at all sorts of times cannot be tolerated. To propose a scheme with any likelihood of general adoption it must interfere as little as possible with this continuity. To meet this situation I would suggest that Saturday morning be set apart each week for the practical teaching, by competent masters of their craft, of the other branches of practice which, owing to the causes mentioned, the apprentice has not had the opportunity of acquiring. It is not, however, so essential that old methods of working be learned as it is that the faculty of observation, reflection and judgment be awakened and matured. When these qualities of the mind are active it is surprising to find how readily all sorts of experience are made use of.

During this second stage of a youth's training, he should be drafted into the metallurgical class, there to learn the nature and composition of the materials with which he works and the scientific principles on which his craft depends. Elaborate courses of study running over three or more years are often laid down as necessary for an apprentice's education. I hesitate to follow the example, as it seldom works out in practice. Give opportunity and advice to the apprentice; any pressure beyond this is usually worse than useless, as his further progress rests with himself. If he means to get on nothing can hinder him. If he does not, nobody can carry him to his goal.

Pattern-Shop Training.

Should the boy be more fitted for the pattern shop or drawing office (having at school shown a decided aptitude for such work), his first year or two should be spent in "tidying up," learning the tools and their uses, the materials in which he will work—wood, plaster-of-Paris, clay, lead, etc., used in the shop. He should also get an insight into moulding in sand, in fact should spend some months in the moulding shop, and generally wait upon the men. His evening course of training should be very similar to that already sketched, except that drawing of all kinds should take a large place.

After two years or so he should be placed at a bench between experienced workmen, and under the guidance and control of one of them. His further studies should embrace the higher branches of drawing, design, metallurgy, and a little mechanics and mathematics.

With such opportunities he also may be left to himself for his future development. If made of the right sort of stuff he will open his eyes and find that kind of knowledge most suited to his needs; grit will do the rest. Having spent a little time in practical work in the moulding shop, while studying the elements of metallurgy, he will be in the right way to avoid the many weaknesses in the construction of patterns which contribute in some measure to the moulder's scrap heap.

Drawing-Office Training.

With reference to the drawing office. While many youths are educated specifically for this work from school, I am strongly of opinion that the best recruits for the drawing office are to be found amongst those who, having passed a year or two in the pattern shop, have shown some special aptitude whilst there and in the evening school for work of that description. In any case, the youth intended for the drawing office must spend some part of his apprenticeship both in the pattern shop and in the foundry. It is impossible to design patterns of a satisfactory form, from either the patternmaker's or moulder's point of view, unless the designer has practical and technical knowledge of the essentials of both these departments.

I have set out no "cut-and-dried" course of study extending over very defined lines and covering a considerable time, because I hold a strong conviction that such a plan would be either ignored by the mass of youths with whom we are dealing, or the youth who followed out such a course of study would not be found in our shops at the end of it.

With reference to the making of foremen and managers, I am even less inclined to dogmatise or to lay down a plan of education. The successful manager is born, not made. The best craftsman will not necessarily make the best manager—often the reverse. To a complete knowledge of his craft a manager will need to add a level head, a wide outlook, and a deep insight into human nature. He must have courage and independence enough to speak the plain truth to either workman or employer, and must not be greatly upset if he gets hard knocks from both as his reward. Yet his power in the direction of creating a good understanding between them is unbounded.

Discussion.

Mr. Key said Mr. Sherburn had told them how he would train and educate the boy, but he had not taken into consideration a matter of equal importance, namely, the character of the man with whom the boy was to work. The boy fresh from school on going into the foundry found himself with other lads in an atmosphere of comparative freedom, of which he soon set himself to make the most. When after 10 or 12 months he became capable of doing certain work, the man would say to him "Hold on, you are only getting 6s. a week, and I am getting 36s.," with the object of keeping the boy's production as low as possible.

Mr. Cordingley remarked that at present a boy had to devote three nights a week to attending classes, and if he wished to make good progress, he must do work at home as well, on the other evenings. Then the employer wanted his full tale of work in the day time, so that if the lad did all that was required of him, he must be nothing less than a giant. For his own part, if a boy went to a class three nights a week, he did not think there was any necessity for making him do home work as well. He quite agreed that drawing was an essential element in the education of a boy who wished to go into the foundry. In the present day there was so much specialising in work that boys did not get the round of the shops, and it would be a good thing if they could get back to the old methods, under which a lad went through the whole course of the work.

Mr. Dealley said the cry that they could not get apprentices was common in America, and the same state of things obtained in Germany. Personally he was quite sure that the future of the apprentice was greater than ever it was. The old system had fallen, because the times had changed; the system when every part of the work of apprentices was done under personal supervision has passed away. In their works they sent the apprentice into the foundry for about 16 weeks, and then waited for another boy, preferring one not too big to carry messages, or to wait upon the craftsman. A system of apprenticeship different from the present would have to be designed. Every manufacture was very much cut up, and they saw the cleavage going forward among the men. There was a large number of skilled and highly cultivated craftsmen, and then down below them there were the others. The tendency was to lift the former up. There were so many jobs that they kept all their best men on the best part of the work, and all the worst, the mere labourers, on the rest of the work. That was a problem which he had found it very difficult to handle. The necessity for apprentices was fifty times greater than it used to be, but they required a different sort of apprenticeship. Another point was drawing, and he had come to the conclusion that in the technical schools generally, they taught men drawing as if they were all going to be draughtsmen. When he asked some of their apprentices if they could not practice drawing at home, they replied that it would need spending about £20 in order to do it. All he should have thought to be necessary was a piece of paper, and a pencil to draw views. Drawing was a technical language, and spoke to every one at once. The schools had been teaching on wrong lines, and people were just beginning to find it out. There was a Bill before Parliament for the compulsory extension of attendance at evening classes, but he was very strongly of opinion that this was not the time to force lads of 14 into evening classes. Let them exhaust the possibilities of the voluntary system, and see how it would work. He would like to see a school shop established, and if it worked well they could start another. If part-time schools were made compulsory by Parliament, he certainly thought the scheme ought to embrace all boys, and not those only of certain trades picked out for the purpose. He would place the leaving age at 14 and nothing under, and would alter the day schools and the evening classes so as to ease off the line between school and work as much as possible for the boys.

Mr. Penlington said the last speaker informed them that he allowed four boys to go off on the Monday to attend a day class, and could find more if they could spare them. That was just the trouble in every firm, and in every department of the firm—how to spare the boys. The boys were doing work which dovetailed into the work of others, and while they were away, that particular part of the machinery was "looking on," so that some must suffer. He would suggest, and the suggestion had been taken up by some firms, that instead of sending the boys out to the class, the firm should fit up a saloon, furnishing it with books, drawing materials, etc., and allow all the boys employed by them to attend at different times, some on Monday, others on Tuesday, and so on. They should have a draughtsman to assist them, and the results of their work could be sent to the Technical School to be examined. That would largely get over the difficulty of sending the boys away from the works. He (Mr. Penlington) contended that the old system of apprenticeship had not failed—the old system of craft guilds, in which a boy lived and worked with his master, and learned his business thoroughly. That system did not fail, and would not fail if it could be tried again, which, however, it could not under existing circumstances. Mr. Key had spoken very pessimistically about the men and their influence

on the boys; he (the speaker) had certainly not found such apathy and discouragement on the part of the men towards the boys. On the contrary, he thought the men did all they could to assist a boy when they saw he was doing his best. They knew what they would like, and what was the proper method of training apprentices, but the question was, how were they going to put their ideas into practice. A firm could not allow a boy to devote so much time to learning this and that; he had to be put on to work that was required and necessary in the shop. One method he had adopted in training apprentices was to create a desire in them for information. Instead of devoting a particular morning in the week, as Mr. Sherburn said, to the purpose, whenever a casting was made and anything went wrong, the boy was brought in, and asked if he knew why it had gone wrong, and how the defect could be remedied. The next time the lad would very likely ask questions, which showed he had got the desire to learn.

Mr. Norris thought it would be much better for a boy to serve 12 months in three or four different shops, and thus obtain a thorough understanding and knowledge of the work done—making them, in fact, all-round men.

The Chairman said he had just been wondering whether, after all the discussion that had taken place, any real furtherance had been made towards a solution of the problem. Mr. Arthur Greenwood, of Leeds, recently observed that "the future welfare of the child was sacrificed to immediate commercial needs." Teaching of this trend made the task very difficult for those who were anxious to try and improve the apprentice in any trade, because the boy was more apt to swallow such words than listen to sound common sense. Mr. Sherburn said they must begin with the school, and he was quite with him in that opinion. For some years he had sent to a school within easy reach of their works, and extended invitations to boys in Standard 7 x to pay them a visit. He took the boys round the foundry, starting from the raw material and going through all the departments, and when they left, he made each of them a little present, a pair of dumb-bells or a small ornament, which would remind them of their visit. Those were the lines he thought they should work upon. Then he induced the proprietors to offer prizes of 5s. each in a bank book, to those lads who wrote the best account of what they had seen in the foundry. If arrangements were made whereby boys could be taken to different kinds of works, and thus enable them to judge which they would like to go to, some would choose one and some another, according as their interests were aroused in what they saw. He did not think any fixed school training did much good; it was necessary for the boys to go into the workshop in order to get that. If there was any particular piece of work which a youth could do better than a man, they ought to let him have it.

Mr. Sherburn, in replying, said he aimed at a high ideal in educational matters, and, moreover, did not regard our commercial system as perfect. He believed in 14 as the age limit for school, for he saw no good in keeping a boy there against his will, and if they could teach him to keep his eyes open to what was going on around him, he would soon learn more than all the book learning could give him. The present educational system was wrong, and if they could do anything to influence the Government officials, they should do it right away. (Applause).

A hearty vote of thanks was accorded to Mr. Sherburn for his Paper.

Discussion on the Cupola.

At a recent meeting of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association a question was discussed which read as follows:—"Is it possible with two cupolas, each cupola melting the same amount of iron per square inch of area, for one cupola to burn more coke than the other." The Chairman asked whether it was understood that there would be one blower for two cupolas.

Mr. A. B. Gallon, who had handed in the question, expressed it rather more fully. There were two cupolas, one of, say, 4 ft., and the other 2 ft., each melting at the same rate of, say, 8 lbs. per square inch of area per hour. One foundryman said he could melt 20 cwts. of iron with 1 cwt. of coke, and the other said he could melt 30 cwts. of iron with 1¼ cwt. of coke, or about 24 to 1. His (the speaker's) assertion was that he could only melt 14 to 1, but he might melt at the same rate per square inch of area as the other cupolas. The difficulty was that he was melting at the same rate as the other cupola but he was using a third more coke.

Mr. Paulin said the question could only be disposed of properly and intelligently by getting hold of all the data available on the subject. He thought, however, that if Mr. Gallon was melting at the same rate per square inch of area he was not burning coke at the same rate. It depended upon the amount of the charge of coke in relation to the iron. He had known a man by careful handling to reduce his coke consumption considerably. The question was, how would that affect the castings? In all those things they must look at the matter of the coke in relation to the molten metal.

Mr. Carmichael thought that, supposing the two furnaces were of exactly the same design, and with the same pressure of blast, and in every way equal to each other, if one melted at the rate of 8 tons an hour with a charge of 1 cwt. of coke to 30 of metal, the other should do the same. They should burn the same amount of coke; they should get metal at the same speed and the same quantity per hour. It greatly depended upon the quality of coke used. Two furnaces alike, using the same quality of coke, then, he thought, should give equal results, and he was of opinion there was nothing to prevent them doing that.

Mr. Smith said the two furnaces were not alike in size, and he thought that was the point.

Mr. Varty said that since the difference in the castings turned out would be very great, before any comparison could be made they should have carefully tabulated data.

Mr. Gallon, continuing, said it did not matter what castings were got; the question was that both cupolas were melting at the rate of 8 lbs. per square inch of area, and one was using one-third more coke than the other in the same time.

Mr. McLaughlin considered that with two cupolas, one 4 ft. diameter and the other 2 ft. diameter, the small furnace would use very much less coke than the larger furnace.

Mr. Carmichael said that undoubtedly the consumption was greater per square inch with the bigger cupola. There was a great difference between one, say, 3 ft. inside diameter and another 18 in. inside diameter. One reason he would suggest was that the walls of the furnace might be thinner in one than the other; also there was less area for the gases to ascend and was more confined.

After further discussion it was decided to postpone consideration of the subject until the next open-discussion night.

A Modern Brass and Aluminium Foundry.

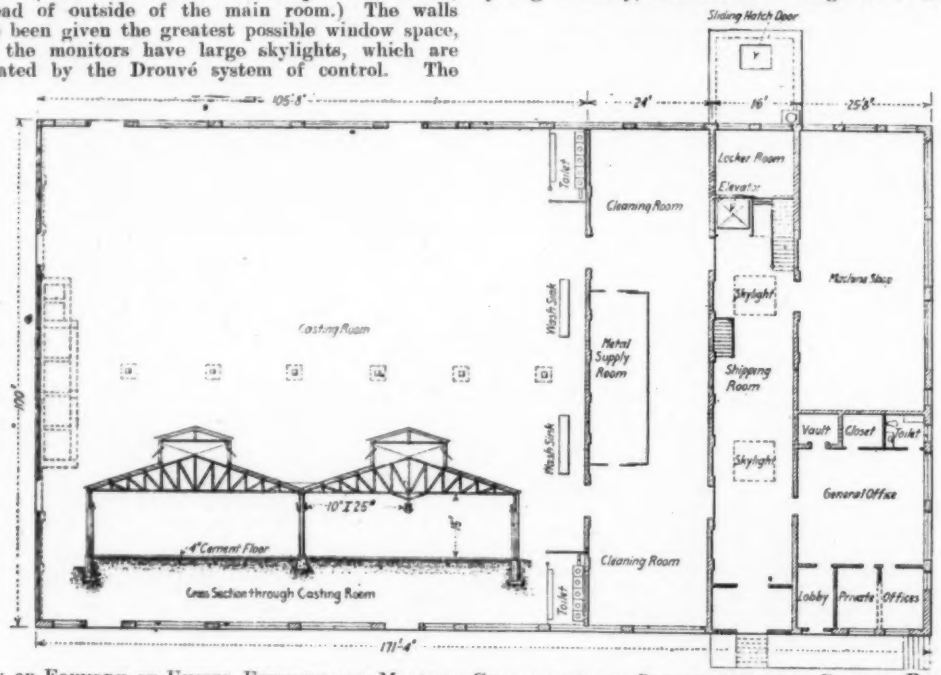
The following particulars relating to the plant of the United Foundry and Machine Company, Bridgeport, Conn., U.S.A., are taken from a brief description published in "The Iron Age." :—

The Company is operating a new aluminium and brass foundry which affords an interesting exposition of the advances that have been made in the past decade in the science of casting aluminium. In the equipment, which gives a capacity of 15,000 lbs. of aluminium and 10,000 lbs. of brass per day, and in the practice employed, the foundry represents the latest word in the industry.

The building is of brick, with steel trussed roof, 100 by 171 ft., one storey and basement. The foundry proper is 100 ft. square. A temporary wooden lean-to at the rear accommodates the core ovens. (These are shown on the plan as within, instead of outside of the main room.) The walls have been given the greatest possible window space, and the monitors have large skylights, which are operated by the Drouvé system of control. The delivered by gravity to storage compartments beneath a trestle. Travelling cranes minimise the labour of handling heavy flasks and patterns and the castings themselves.

The two departments are kept entirely separate. The furnaces are grouped at the centre of the foundry floor, a battery of brass furnaces (by the Monarch Engineering and Manufacturing Company) at one side, and a battery of aluminium furnaces (by the J. D. Smith Foundry Supply Company) at the other. All work is kept in its own half of the building, both in the foundry and in the cleaning room, that no accidental alloying may occur to mar the uniformity of the product. Moulding machines are employed for both light and heavy work.

Only a few years ago, in the infancy of this still young industry, aluminium castings were broadly



PLAN OF FOUNDRY OF UNITED FOUNDRY AND MACHINE COMPANY; WITH SECTION THROUGH CASTING ROOM, SHOWING SUSPENDED CRANE RUNWAYS.

lighting and ventilation are all that could be desired. In the basement is a room in which are located the Norwalk compressors, and also a large vault that provides for ample pattern storage. At the front of the main floor are the offices and a machine shop, and back of this space are the cleaning rooms and the metal storage.

The foundry floor is of concrete, instead of the usual dirt and sand, giving a smooth surface that makes the work of the moulders more efficient, and which is easily kept clean, so that metal which may be spilled or thrown upon it may be reclaimed with little effort. The product is handled economically from the receipt of the raw materials to the loading of the castings for despatch. A spur track from the main line of the railway brings the trucks of metal to a loading platform, while sand and fuel are

condemned for their poor machining qualities, their low strength, and their ductility. In many cases in which they could be used to advantage in place of iron, or brass, they have not yet been adopted, because of a lack of comprehension of the great strides that have been made in the art. Formerly the metal was poured too hot. Now it is known that above 1,500 deg. F., no additional fluidity is obtained, while strength is vitally affected. The knowledge of alloys has also increased greatly and to-day a great range of physical qualities may be obtained by varying mixtures. Equally important are the advances in mechanical processes of manufacturing castings. Gates are of great size and extend through the lighter parts to the heavy, making it possible to pour at low temperatures and giving uniform shrinking. The use of chills is better under-

stood. Pyrometers regulate the heat for different classes of work. The addition to the aluminium is usually either copper or zinc, a small amount of copper being added to the zinc in some cases. The aluminium-zinc alloy has approximately a tensile strength of 30,000 lbs. per sq. in. However, it lacks the hardness which would make it suitable for such parts as gears. The automobile manufacturers prefer for the greater part of their work an alloy which consists of 92 per cent. of aluminium and 8 per cent. of copper. This mixture, while not quite as strong as the zinc alloys, is the safest to cast because it is not subject to cracking.

Iron-pot furnaces are used for melting aluminium, and the metal is handled with iron ladles, from which it is poured direct into the moulds. A special iron is used for this purpose. It is cheaper and more durable than graphite and the amount of iron taken up by the aluminium is so insignificant that it has no appreciable effect on the strength of the castings. Much care, however, is taken to prevent overheating, and also in stirring, to ensure that iron is not scraped from the kettle or ladles.

The metal is cast in green sand, which yields more readily than dry sand, permitting of free shrinkage, and being also cheaper. The cores must necessarily be soft, and on this account the larger cores are not dried right through, the application of the gas torch being sufficient. The soft interior yields easily and the dry exterior surface prevents blowing when the metal strikes it.

Foundry Sands and their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 31.)

Practical Illustrations of Typical Moulding Sands, Fireclays and Refractory Materials after Testing.

In order that foundrymen and those interested in refractory materials may obtain a better idea of the value of practical tests in the selection and use of such materials in the foundry, results of actual tests conducted on samples of well-known materials used in every-day practice are given herewith. The salient points of such tests are :—(1) Surface factor or size. (2) Percentage of water (hygroscopic), the material requires for maximum cohesiveness when dried one hour at 100 deg. C. (3) The venting capacity or porous property of 1 cub. in. of material when mixed 400 times with a pre-determined percentage of water, and rammed or subjected to a pressure of 25 lbs. per sq. in. (4) Actual physical changes wrought in the material by exposure to different pre-determined heats. These latter can only be illustrated by photomicrographs, as no literary description would suffice unless accompanied by the evidence of such photographs. Consistency and colour of material are often of great help in deciding fine points, but the chief and final considerations in regard to a moulding sand mixture seem to be size, cohesiveness and refractoriness.

Chemical analysis here has been purposely avoided, principally because almost every moulding sand, fireclay, or refractory material possesses a distinct analysis; and scientists generally have been unable to reconcile such analytical data with the physical conformity of refractory materials when exposed to high temperatures, within limits of up to 7 per cent. total impurities in a green sand and 10 per cent. in a "composition." By this it does not necessarily mean that chemical analysis is no guide to an unproved or old sand mixture or composition, whose total impurities, whether in the form of metallic oxides, slag, magma, or other fluxes, exceed the prescribed limits.

The size or surface factor of a sand as determined by sieves of 50 and 100 mesh can be easily arrived at in practice with sieves of such dimensions, and these, as far as the busy foundryman is concerned, answer his requirements. Of course, the use of various other sized sieves is an advantage, but it tends to complicate a present simple method, which if rendered more complex would soon become discarded as useless.

Moulding sands having to be used as dry as possible, it is important to know what percentage of hygroscopic water the material should contain to ensure maximum cohesiveness. This is best determined by drying out the original hygroscopic water in an oven for one hour at a temperature not exceeding 100 deg. C. When the sample has been dried, rubbed in a mortar, and sieved, water from a burette is added until the maximum cohesive state has been reached in the process of mixing. The latter is best proved by working the sand in an actual mould.

Having found the mean average percentage of water required to mix with a dried sample, it is necessary to determine the venting capacity or porous property of the mixture itself; in other words, to ascertain what resistance a fixed amount of sand offers to a given pressure of gas or air when rammed or compressed in a vessel or mould at a given pressure (usually 25 to 50 lbs. per sq. in.). The experiment or test is carried out by ramming some of the moistened sand in a cylindrical vessel whose internal volume measures one cubic inch. The compression or density test is performed by means of a "Curtis" mould tester at any desired pressure. After ramming, a cap is screwed on the top of cylindrical vessel having a small hole in its centre. The bottom of the vessel which terminates in a suitable connection, is fastened to rubber tubing, being finally connected to an oxygen cylinder. On the latter is fitted a regulator, and by means of its diaphragm the pressure in the cylinder can be controlled within the limits of from 1 to 30 lbs. per sq. in. Having arranged the complete apparatus, a current of oxygen at 1 lb. pressure is turned on and forced through the sand core enclosed in the cylindrical vessel. The resistance of the sand core to a given pressure of oxygen, without showing any signs of a rupture or aperture, is the venting capacity or porous property of the sand in lbs. per sq. in.

A selection of photomicrographs and details of tests are reproduced, with the hope that founders and those requisitioning or using moulding or refractory materials may adopt a certain standard of specification which conforms to those results only obtainable in actual practice.

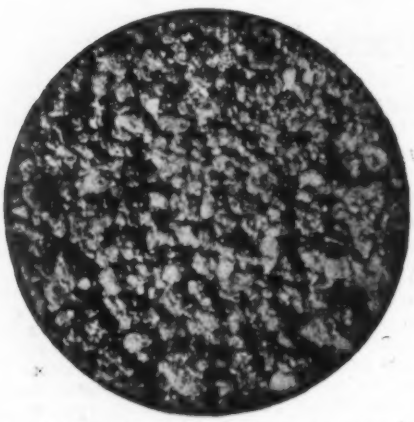
(*For photomicrographs see pages* 92-95.)

(*To be continued.*)

Tests for Refractory Values.

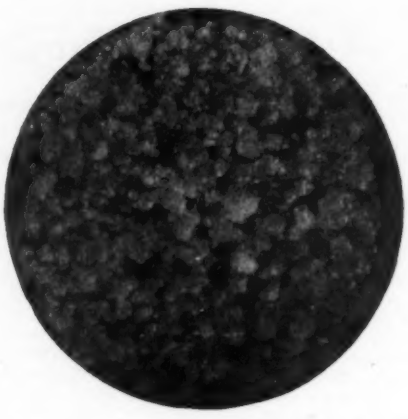
Material Tested :—**WARWICKSHIRE SAND (Birmingham Cemetery).** *Weight of Sample* :—100 Grammes.
Colour and Description :—Very Light to Light Brick Red. *Consistency* :—Medium Strong.
Number of Test Pieces :—Eight.
Surface Factor or Size :—(Grammes per cent.)—Retained on 50 Sieve, 1.020; on 100 Sieve, 42.270; Sieved through a 100 Sieve, 56.710.
Percentage of Water Material Requires for Maximum Cohesiveness when Dried One Hour at 100 Degrees Cent.:—3.80 C.C. per cent.
Venting Capacity of 1 Cubic Inch when Mixed 400 Times with 3.80 per cent. Water and Rammed at a Pressure of 25 lbs. per Square Inch :—About 4 lbs. Air Pressure.
Plate.—Wellington and Ward, Anti Screen. *Objective.*— 1 in. Watson; Camera Extension 2⅜ in.

Photomicrographs shewing Refractory Value of Material Tested.



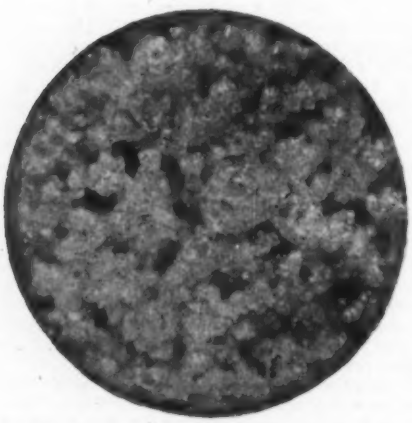
No. 1.—Material at Normal Temperature. Magnification: ×50 Diams.

Remarks.—Medium Fine Sand. Works Soft. Requires Little Water.



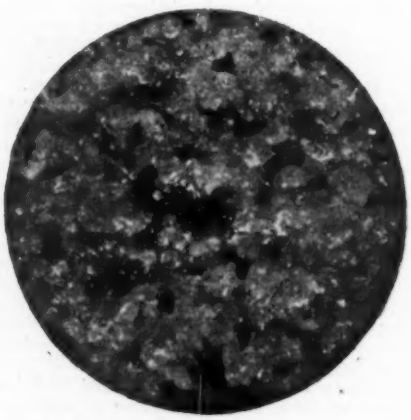
No. 2.—Material after Exposure to 1,200° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded Slightly, then Broken Flat by Heat. Bleaching Action of Clay Begun.



No. 3.—Material after Exposure to 1,300° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of 2½in., then Broken Flat on Cooling. Sand Grains begun to Fuse Together.



No. 4.—Material after Exposure to 1,400° Centigrade. Magnification: ×50 Diams.

Remarks.—Expansion same as No. 3. Sand Grains Fused Together in Bunches or Aggregates, showing Deep Fissuring by Iron Present.

Test for Refractory Values (continued).

WARWICKSHIRE SAND (Birmingham Cemetery).

Photomicrographs shewing Refractory Value of Material Tested.

No. 5.—Material after Exposure to 1,500° Centigrade. Magnification: ×50 Diams.

Remarks.—Expansion same as 3 and 4. Material nearly Completely Fused, showing Deep Fissuring due to Pressure of Iron, etc.

No. 6.—Material after Exposure to 1,600° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Broken by Heat. Material Completely Fused to a Whitish Greyish Green Glass. Exfoliation Commenced.

No. 7.—Material after Exposure to 1,700° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Broken by Heat. More Exfoliation. Material Fused much Deeper into Specimen to a Whitish Grey-green Glass Heavily Pitted with Impurities.

No. 8.—Material after Exposure to 1,800° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded $\frac{3}{32}$ in. in the Form of a Camber in a Length of 2½ in. This was due to the Whole Surface of Specimen being Fused to a Thick Glass, Whitish Grey-green in Colour. No Exfoliation, but Heavily Pitted and Fissured.

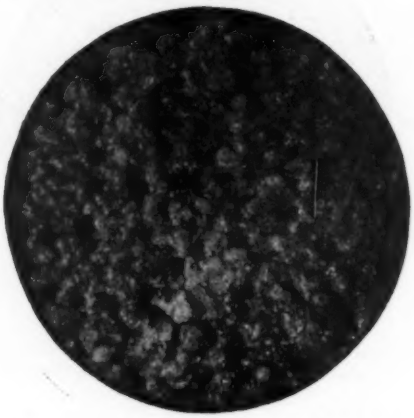
Tests for Refractory Values.

Material Tested :—**CUMBERLAND SAND (Carlisle District).** *Weight of Sample* :—100 Grammes.
Colour and Description :—Dirty Dark Brick Red. *Consistency* :—Under Medium Strength.
Number of Test Pieces :—Eight.
Surface Factor or Size :—(Grammes per cent.)—Retained on 50 Sieve, 7.150; on 100 Sieve, 30.920; Sieved through a 100 Sieve, 61.930.
Percentage of Water Material Requires for Maximum Cohesiveness when Dried One Hour at 100 Degrees Cent.:—Five C.C. per cent.
Venting Capacity of 1 Cubic Inch when Mixed 400 Times with 5 per cent. Water and Rammed at a Pressure of 25 lbs. per Square Inch :—About 3 lbs. Air Pressure.
Plate,—Wellington and Ward, Anti Screen. *Objective*.—1 inch, Watson; Camera Extension, 2⅝ inch.

Photomicrographs shewing Refractory Value of Material Tested.

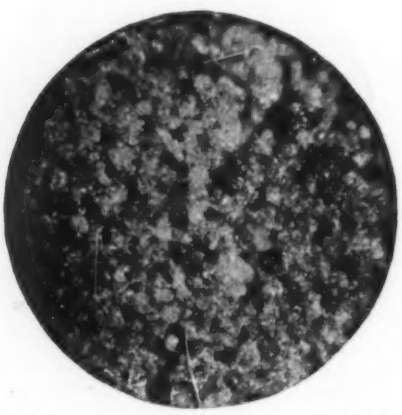
No. 1.—Material at Normal Temperature. Magnification: ×50 Diams.

Remarks.—Material Works Somewhat Sharp and Gritty. A Few Large Pebbles Retained on 50-mesh Sieve about ⅛ in. in Diameter.



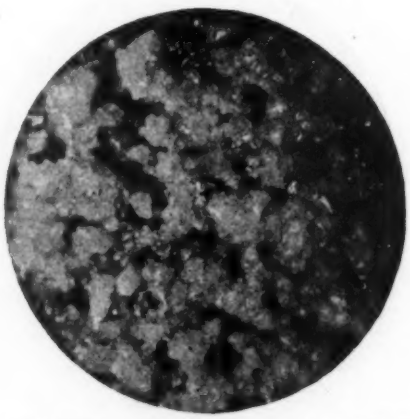
No. 2.—Material after Exposure to 1,200° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Weak. Flat. No Expansion. Bleaching Action of Clay Begun.



No. 3.—Material after Exposure to 1,300° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded 1/64 in. in the Form of a Camber in a Length of 2½ in., then Broken Flat by Heat. Weak, but no Exfoliation.



No. 4.—Material after Exposure to 1,400° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded 3/32 in. in the Form of a Camber in a Length of 2½ in., then Broken Flat on Cooling. The Smaller Sand Grains Fused in Bunches or Aggregates. Heavy Pitting and Fissuring.

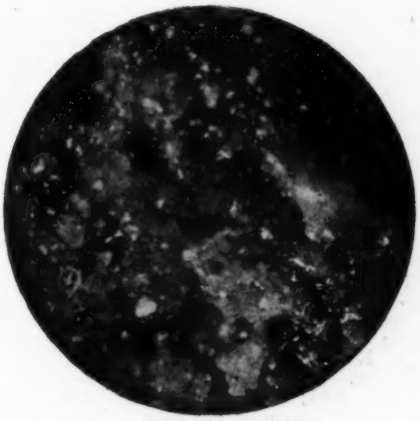
Tests for Refractory Values (continued).

CUMBERLAND SAND (Carlisle District).

Photomicrographs shewing Refractory Value of Material Tested.

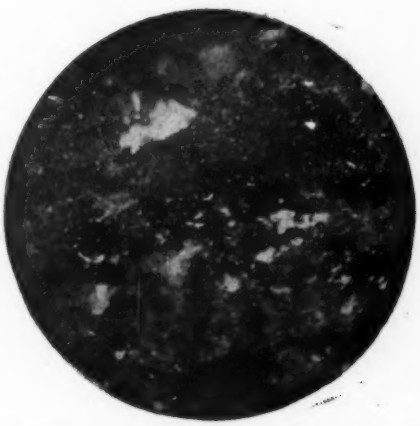
No. 5.—Material after Exposure to 1,500° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Expanded as in Fig. 4. Material Partly Fused, showing Pitting and Deep Fissuring due to Iron, etc.



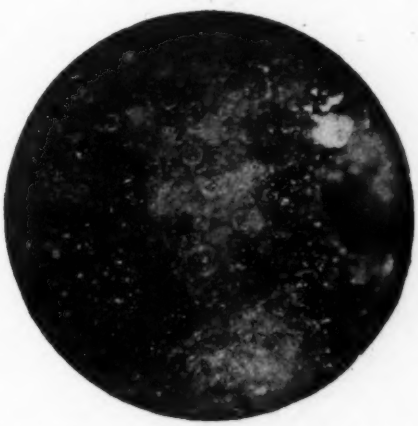
No. 6.—Material after Exposure to 1,600° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Broken by Heat. Material Nearly Fused. Very Slight Exfoliation. Very Heavy Pitting and Fissuring due to Impurities.



No. 7.—Material after Exposure to 1,700° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Broken by Heat. Material Completely Fused to a Dirty Grey Glass, showing very Heavy Fissuring and Pitting due to Large Grains of Free Felspar and Iron.



No. 8.—Material after Exposure to 1,800° Centigrade. Magnification: ×50 Diams.

Remarks.—Test Piece Broken Flat by Heat. Very Slight Exfoliation. Material Completely Fused to a Dirty Grey-black Glass, very Heavily Pitted and Fissured with Impurities.

Notes Concerning Cupolas.

Under this title Herr Mertens gave some interesting information on German foundry practice before the recent Convention of the German Foundrymen's Association. An abstract of the Paper is translated herewith:—

Although in the recent years vigorous efforts have been made to place the melting department on a scientific basis, there are still many foundries which are opposed to any innovations. Indeed, there are foundries which do not even weigh their charges. There would be a great difference if the specifications concerning castings were more sharply drawn. Nowadays, many machine-shops lay special stress on having soft castings; but great tensile strength, which goes hand in hand with increased hardness, is less appreciated.

The question of machining the castings is intimately connected with the "mix." The most simple mixture known to the author consisted of the very ordinary cast scrap, with solid grate bars, pieces of dirty sewer-pipes, and the like. The iron was, as a rule, melted in the ordinary furnace; and its use was confined to simple plate-castings for building purposes, etc. Its chemical analysis was about:—Si, 1.66; Mn, 0.30; P, 1.30; S, 0.175. The loss in melting was about 5 to 8 per cent., and the castings brought about £4 10s. per ton.

A somewhat better mixture for ordinary castings was made with the same scrap, plus about one-third No. 3 or No. 5 Luxemburg pig or No. 3 German foundry iron. This material was composed about as follows:—Si, 1.65; Mn, 0.37; P, 1.05; S, 0.16. This low-grade scrap was used not only for ordinary castings, but also for machines; often as much as 30 per cent. being used.

Most foundries work with the so-called average mixture, from which all kinds of castings, no matter how different they all may be, are run. As a rule, this mixture consists of 20 per cent. hematite, 25 per cent. No. 3, 30 per cent. bought scrap, and 25 per cent. gates and own scrap. The pig forms, according to the kind of castings, about 40 to 60 per cent., but some foundries run machine castings from pig only, for instance, hematite and German No. 3; in some cases there is added 10 to 20 per cent. and even more of briquetted scrap. The introduction of this latter has led many foundries to pay considerable attention to the question of mixtures. The inseparable characteristics of briquetted scrap, low silicon and high sulphur, as compared with the pig and loose scrap has in some foundries prevented success; but in most cases it can be shown that this is due to improper proportions, and not to the use of briquettes. The addition of 10 per cent. of the latter to the normal mixture for ordinary machine castings is usually accompanied with no difficulty; but one must take into account the reduced silicon contents of the briquettes. Very often these are used without any regard to the composition of the pig. If the pig is low in silicon the addition of briquettes causes considerable shrinkage, but if the silicon is high castings can be made without pipe. The temperature of the melted iron has also an influence on the formation of pipe. The excessive shrinkage is most often noticed where the iron has not been hot enough. It is, therefore, necessary not only to have the right mixture, but also to have the furnace properly managed.

The author then referred to the work done on the subject of furnace operation by Wüst, Lürmann, Osann, Messerschmidt, Rein, Busek, Schoemann, West and Moldenke. They were unanimous in agreeing that the amount of air must be suitable to the cross section of the cupola. But in many quarters much weight was laid on high blast-pressure, and in another on the advantage of as much air as possible. In both foundries, however, the cross section of the furnace was left out of consideration; and for this reason very unfavourable melting conditions often resulted. The author gave several examples from actual practice, in order to show the faults, even with new melting plants. In one large works, with the most modern furnaces with a capacity of 7 tons of metal per hour, the melting was bad. Every day there was trouble for a longer or shorter time with dead iron. There was too much slag, which was easily accounted for by the fact that with every charge 5 per cent. and more of limestone was added; considerable dirt got into the furnace, and the lining was badly attacked.

The waste was principally by reason of dead iron, porous places, slag and pipe. Sharp inspection revealed the causes of the trouble; on account of insufficient blast, the melting capacity of the furnace was reduced. The furnace was eventually lined in the melting zone so that the amount of air was in proper proportion to the cross section of the furnace. Care was also taken that there was sufficient coke filling. The experiments in melting showed that with proper attendance on the furnace, even with insufficient blast, a good iron could be obtained.

In another foundry there was complaint concerning castings being too hard; after the amount of blast from the Rateau blower and the quantity of coke were adjusted to the cross section of the furnace, normal conditions were soon attained. The addition of 5 per cent. of briquetted scrap showed no change in the hardness of the iron. As, after a while, there were again complaints about too great hardness, the analysis showed that the mixture was not the cause, and further observation of the melting showed that it was in the furnace.

The author then mentioned a third case where lack of coke was the cause of decarburisation and reduction of silicon content. This was in a very carefully conducted works, in which every day from 12 to 15 tons of high-grade machine castings were made. The cupolas melted normally about 3½ tons per hour; the charge was about 880 lbs., and only 48½ lbs., or, say, 5 per cent., of coke was used with every charge. The analysis of the mixture showed:—Total carbon, 3.35; graphite, 2.10; Si., 2.12; Mn., 0.47; P., 1.15; S., 0.082. The furnace seemed to leave nothing to be desired, and the iron was always very hot and liquid.

The mixture used sometimes gave rise to piping. For this reason it was changed and also about 5 per cent. of briquettes added. Then the analysis showed that the proportion of silicon was reduced, but the castings were perfectly soft and easily machined. Piping had almost ceased. As soon as the insufficient quantity of coke was increased from 5.5 to 6.5 per cent., the iron was still softer, and the piping ceased; so that it may be considered that the low proportion of coke, which in this case led to the formation of CO_2, by reason of the strong blast in the melting zone, was the cause of the decarburisation and the drop in the proportion of silicon.

In the cases above mentioned, as regards the action of the furnace, there were three different faults:—(1) Too little wind and sufficient coke; (2) Too much

wind and too much coke; (3) Too much wind and too little coke.

Discussion.

In the discussion which followed, HERR DAHL remarked that it would be desirable to go further into the connection between the cupola and the auxiliary machines, as, for instance, the blast.

HERR GILLES wished to know something more concerning the furnace which, with 5 to 6 per cent. of coke yielded a liquid iron. He could not get this with his furnace with less than 8.5 per cent. of coke. Very often manufacturers of furnaces guaranteed that 7 per cent. of coke would be enough; but in practice he found that he could not do with less than 8½ per cent.

HERR MERTENS said that he had good results with several furnaces with only 6 per cent. of coke; but must remark that these were small ones of only 27½ ins. diameter. For greater cross section there must be a greater proportion of coke. Also, one must pay attention to having a regular charge; in small furnaces, especially, large pieces should be avoided. The foundries in question worked with good coke, and the castings left nothing to be desired. At the same time success with 6 per cent. of coke was not unusual. The furnaces in question were of normal construction with a fore-hearth and one row of tuyeres as low down as possible. He thought that with proper charging the height of the melting zone was unimportant. As a rule the charge was 10 per cent. of the hourly capacity. Only air-dried coke was used.

HERR SCHARLIBBE remarked that the author had spoken of only 5 to 6 per cent. of briquettes, but at Borsig's, the first establishment in Germany to use them, there was used for cylinders as much as 30 per cent. of briquettes; and for machine castings 25 per cent. At the same works pistons and plungers were made with success with 70 per cent. of briquettes.

Accident Prevention.*

BY THOMAS D. WEST.

About five years ago the writer started the American Anti-Accident Association at Sharpsville, Pa. The work of preventing accidents was greatly taken in by many quarters, but the writer regretted to note that the personal factor he had laid so much stress upon was being superseded by an advocacy of safety devices. However, while he had strongly advocated these also, he felt that time would show that the personal equation would have to be considered, in order that any great notable advance in the saving of life and property caused through accidents could be achieved. This period is now with us. Whatever city one may visit to-day is seen evidence of the necessity of considering the personal factor in preventing accidents.

There are few occupations more hazardous and subject to accident through ignorance and error of judgment than the winning of metals from the earth and their conversion into articles of commerce. The risks incident to this, as well as every other activity, whether commercial, industrial, mining or the like, can often be greatly minimised or even averted altogether by conscientious effort on the part of the supervisors of the men engaged.

In order to decrease the number of accidents materially, two factors must be taken into account. The first is that some accidents, or classes of accidents, can be prevented by the simple exercise of judgment on the part of the men who can reason. The other factor is the less patent one, as it has to do with happenings which cannot be foreseen. Thus, a wreck may occur on a railroad either as the result of an open switch or a broken rail. The first case falls within the range of readily-preventable accidents, as the man throwing the switch should have reasoned properly. The latter case, however, could not have been foreseen ordinarily as things go. It may be stated that for every one accident of the latter class, there are many of the first.

Even the development of the multitude of safety devices, though doing much good along correct lines, has not reduced the accident percentages to any very notable extent, simply because the personal factor—the continually anticipating what would happen if certain conditions should prevail—has not been emphasised properly. It seems unfortunate that our social and business fabric is such that credit is given the man who cures rather than the man who prevents accidents to life and damage to property. Nevertheless this should not deter us from doing our manifest duty as citizens and men in removing every factor that may lead to injury to or actual loss of life and property.

The supervisors of a plant should regularly make it a habit to jot down in a memorandum book any matter arising which might have led to an accident, and how this can be forestalled the next time. The writer has found this to work admirably, and the cost is trifling. Either let the memorandum be jotted down during the day, or at home in the evening in thinking matters over. It would indeed be well if regular blank forms were given to the supervisors of a plant with this purpose in view, as from the record of what occurred and what might have resulted therefrom will be learned the advisable safety devices a plant stands in need of specially. Moreover, this can be extended to include accidents of what might have been injurious to the property itself, and even the business.

The recent expansion of accident liability is quickly increasing the insurance rate of those works in which the hazards are extra large on account of the indifference of the supervisors. It will eventually cause the rejection of many, or at least limit the compensation, amounting to extra premiums. It is quite evident that the original plan that every line of business shall have a rating to cover all chances of accident within it will not hold. It will happen that individual concerns will find their premiums advanced beyond others, even if in the same line of work, according to the prevalence of accidents they have and the character of those accidents.

State liability laws are being closely watched as to their effect, and some results have come that have not been anticipated, to the discouragement of those who are anxiously seeking proper protection while desiring justice for their employés. There is a general interest displayed and the hope seems to prevail that everything will work out right and equitably.

Everything possible should be done by an establishment to hold its supervisors alive to the importance of preventing chances of accident, to adopt accident prevention and safety devices wherever possible, but not to depend upon these devices to the exclusion of the eternal vigilance required from every individual connected with the place to consider "safety first." It is admitted that all this makes an extra load to carry, but humanity alone would require it, if indeed considerations of self-interest did not make it obligatory at the present time.

* Abstract of paper before the American Foundrymen's Association Chicago Convention. At the conclusion of the paper a committee, with Mr. West as Chairman, was appointed to further its suggestions and other similar work.

Prevention of Accidents in Iron Foundries.

There has just been issued by the Home Office a report, by Mr. Gerald Bellhouse (H.M. Superintending Inspector of Factories, South-Eastern Division) on conferences between employers, operatives, and inspectors concerning safeguards for the prevention of accidents in iron foundries. In the report of the Departmental Committee on Accidents in places under the Factory and Workshops Acts, it was recommended that certain points submitted by representatives of the Friendly Society of Ironfounders should be investigated by the Factory Department, and subsequently discussed at a Conference with the trade. The following were the points submitted :—

(1) Foundries are often badly lighted.

(2) They are very often dirty, and more frequent limewashing might improve the light as well as add to the comfort of the workers.

(3) The habit of laying plates on the foundry floor between the lines of rails is dangerous, because hot metal falling on the plates splashes and causes burns, and because the splashes form into balls, and on the iron plates such balls roll under the feet of the workers and cause falls.

(4) If the iron is allowed to run quickly out of the furnace and in large quantities, the practice of catching it in ladles is dangerous; the witness thought that in no case should it be caught in ladles carried by hand.

(5) Iron plates should not be placed under the furnace spout, as they increase the danger of splashes and burns.

(6) Foundries are often cumbered with the boxes used for sand casting ; men have to carry ladles of molten metal between these boxes, and often insufficient space is left; falls and burns are increased by this overcrowding.

(7) Boys under 18 should not be allowed to carry vessels containing molten metal; to do so requires both strength and skill, and burns often result from the employment of young and inexperienced persons in this work.

Accordingly enquiries were made on an extensive scale in all parts of the country, and certain proposals were formulated for discussion at the Conference, to which were invited four Associations of employers and nine of operatives; and representatives were appointed by all but three of these. The Factory Department was represented by the Superintending Inspectors of each Division, the Inspector for Dangerous Trades, and four other Inspectors (Messrs. H. J. Wilson, C. E. Pringle, D. R. Wilson, and T. Porteus) who had taken part in the special investigation mentioned above. An analysis of accidents reported during 1912 was also put in hand.

The agreements arrived at are not very far-reaching in their effects, for the discussion disclosed wide differences of opinion, not only between employers and operatives, but also between the different representatives of each. The word "foundry" bears rather a different interpretation in Scotland and in England, but in this report it is used as meaning a "moulding shop," and such agreements as have been arrived at are to be understood as limited to moulding shops.

Lighting.—The importance of good lighting from the point of view of safety was not disputed, but in the agenda an attempt was made to fix a standard of efficiency of lighting, and it was upon this that the chief discussion took place. For natural lighting the main proposal was that some minimum relation between window and floor area should be established and a proportion of 1 : 10 was tentatively suggested. This ratio was taken from the Local Government Board Model Bye-laws for the erection of New Buildings, but further investigations, made before the Conference met, showed that (though adequate, no doubt, for dwelling houses) it was much too low for foundries, where the nature of the work hinders reflection of light and thus necessitates more ample provision for its admission. The returns from different districts showed that the actual ratio in foundries is seldom less than 1 : 4, while in newly-built foundries it is often as high as 1 : 1, and in some instances the window area even exceeds the floor area. It became necessary, therefore, to amend the proposal and at the Conference a proportion of 1 : 4 was suggested as a minimum instead of 1 : 10. The question was discussed at great length, but consideration of it was eventually postponed to enable employers to obtain fuller information as to existing conditions. Further proposals for securing efficient natural lighting by keeping windows and walls clean were accepted, with slight modifications, but the suggestion that windows should be washed at least once a month was opposed, and had to be withdrawn, and both employers and operatives objected to the proposed monthly brushing down of walls.

While it is desirable to have some fixed standard for natural lighting, it is even more important, owing to the great variation which has been observed in existing installations, to settle one for artificial lighting. In order to be able to put forward definite proposals on this point, a special investigation was undertaken by Mr. D. R. Wilson (see F.T.J., August, 1913, p. 535). Before the second meeting the announcement was made of the appointment of a Departmental Committee to consider the question of lighting in factories and workshops generally, and Mr. A. M. Smith, speaking on behalf of the Engineering Employers' Federation, intimated that his Association considered it inadvisable to continue the discussion in view of the wider investigation that would be undertaken by the Committee, and must decline to assent to any agreement.

Use of Iron Plates.—A long discussion on the dangers alleged to arise from the use of iron plates (*a*) as gangways, (*b*) under the furnace spouts, disclosed great divergence of opinion amongst the operatives themselves and amongst representatives at the conference generally. The one point upon which there was agreement was as to the necessity of keeping such plates dry. It may be added that there is little evidence that these plates are in fact a frequent source of accident.

Taking Metal from Cupola.—No agreement was come to as to the conditions under which metal might be caught in hand ladles under the furnace spout. The opinion of the meeting was very much divided, and it was finally agreed to delete the proposal.

Overcrowding of Floors.—The rule as to passage-ways between rows of boxes was modified to read :—"Where metal has to be carried by hand between rows of boxes, a clear passage-way of not less than 18 in. shall be left." This change of wording will allow boxes to be placed in pairs where necessary, and will not interfere with the practice (prevailing in certain classes of work) of walking on the boxes while pouring, but it provides that wherever metal has to be carried between rows of boxes a clear pas-

sage-way must be left. The object of the second proposal was to secure a reasonable passage-way round the moulding pits, partly to give facilities for carrying on the work, and partly to guard against falls into the pit. The rule was strongly opposed, and no agreement could be arrived at.

Carrying of Hot Metal.—The rule prohibiting the carrying of hot metal by young persons under 16 years of age was accepted; while that dealing with the carrying of the metal across open spaces was altered to read :—"Where metal has to be carried across an open space, a clear way, dry and covered where practicable, shall be provided between the cupola and the part where the casting takes place; provided that it shall not be deemed to be practicable to erect a covered way, if to do so would interfere with operations necessarily carried on in that space." In its original form this rule was shown to be too drastic. Instances were quoted where metal has to be conveyed across a street and where it would be beyond the power of an employer to conform; similarly, there are cases where metal is carried across a yard in which carting operations have to be performed, or in which cranes are in use.

Lifting Tackle.—The proposed rules as to testing, examination, annealing, and registration of chains, which follow closely on the lines of those in force under the Docks Regulations, were agreed to, with the exception that half-inch or smaller chains are to be re-annealed every twelve months instead of every six, as originally proposed. There was in point of fact very general agreement with the original proposal, but two of the Associations held out for a twelve months' period, and complete agreement was only possible on these terms.

Protection for the Feet.—The proposal in the agenda was that the boots of the operatives should be protected by a flap of suitable material. At the first meeting, after some discussion, the following alternative was suggested :—"That as a large proportion of burning accidents are due to hot metal getting into the boots, it is recommended that close-fronted boots should be adopted by workmen." At the second meeting it was suggested by the chairman that the matter ought to be dealt with on the principle that the protection (which might take the form of either a boot, spat, flap, or other appliance) should be provided by the employer, and that there should be a compulsory clause enforcing its use by the operative. The necessity for action was further emphasised by accident returns, showing that out of 1,296 hot metal accidents reported during the period January to June, 1912, 898 caused injury to the foot or lower part of the leg. The importance of this subject was generally recognised, but the proposal being new, it was felt that it must be considered by the Associations concerned; no agreement was, therefore, come to at the time, and it was decided that each of the parties should communicate their views later. The results in this respect are somewhat disappointing, and the great divergence of opinion amongst those connected with this trade is again exemplified. Amongst the employers, one society reports that, as their members are far from unanimous, they are unable to make any pronouncement on the subject; the other two, while approving the use of foot-protectors, think the men ought to provide their own. Two societies of the operatives are in complete agreement with the proposal, and a third reports that practically all its branches are of the same opinion; on the other hand, three societies are opposed to it, chiefly on the grounds that their members, if they do not use protections, would be subject to penalties and to possible loss of workmen's compensation in case of injury. Little progress has therefore been made with this important subject, though here, if anywhere, opportunity presents itself for a material reduction of accidents. There is unfortunately no agreement, but the subject ought not to be allowed to drop. It has been included in the recommendations appended to this Report, first because the accident returns indicate its necessity, and secondly because in spite of divided opinions, there was, unquestionably, strong support for it amongst both parties represented at the conference.

Provision of Antiseptic Dressings for Wounds and Burns.—The suggested provision was agreed to, but the words "at the factory" were substituted for "in all foundries."

Enforcement of Agreements.—At the conclusion of the Conference a short discussion followed as to the means of enforcing the agreements, and it was generally felt that statutory powers would be necessary. The points dealt with are all outside the scope of the existing law, and if individual employers or operatives decline to be bound by the conclusions of the Conference, no means exist for bringing them into line. It was suggested, therefore, that they should form the basis of Regulations under Section 79 of the Factory and Workshop Act, 1901. Recommendations for Regulations under the Act which embody the agreements reached, and also some additions, are given in an appendix to the Report, and are as follows :—

Recommendations for Regulations.

(1) Regulations to apply to the moulding shops of iron and steel foundries.

(2) Where iron plates are used in moulding shops, either as gangways or under furnace spouts, they should be kept dry.

(3) Where molten metal has to be carried by hand between rows of boxes, a clear passage way, not less than 18 in. in width, should be maintained.

(4) Where molten metal has to be carried across space, a clear passage way, dry and covered where practicable, should be provided between the cupola and the place where the casting takes place; provided that it should not be deemed to be practicable to erect a covered way, if to do so would interfere with operations necessarily carried on in the intervening space.

(5) No person under 16 years of age should carry molten metal.

(6) (*a*) All chains used for lifting or moving any material should have been tested and should be periodically examined. They should be effectually softened by annealing or firing when necessary, and half-inch or smaller chains in general use should be re-annealed or fired once at least within every six months. Chains to which new links or rings have been added should not be used until they have been re-tested.

(*b*) A register should be kept on the premises, containing the distinctive mark or number of each chain, the date of the test, the test load, the safe working load, and the dates of annealing.

(7) First-aid dressings for wounds or burns should be provided and kept at the factory.

(8) Adequate protection for the feet should be provided and maintained in proper order and repair, for the use of all persons employed in any part of a foundry where molten metal is caught, carried, or poured. It should consist either of closely fitting boots constructed without lace holes or other openings in which molten metal can lodge, or of spats, flaps, or other appliances fitting closely above the ankles and covering all such openings in the boot, shoe or clog worn by the worker. Every person employed in any part of a foundry where molten metal is caught, carried, or poured, should, while at work, constantly wear the protection for the feet specified above.

210192A

Making a Belt-Pulley in Loam.

By Sidney G. Smith.

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When one or two special-size pulleys are required, whether large or small, it is an expensive matter to make a pattern. It is cheaper, even, if the cost of making in the foundry is increased, to make the casting in loam, when the cost of the pattern is

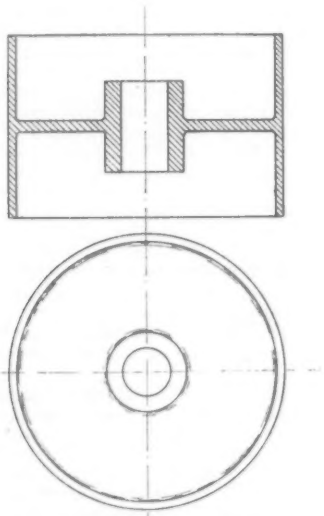


FIG. 1.—PULLEY TO BE MOULDED.

taken into consideration. Fig. 1 is a sketch of a pulley required. No dimensions are given in this case, as the procedure in making a small or medium-size pulley would be the same. With a large pulley

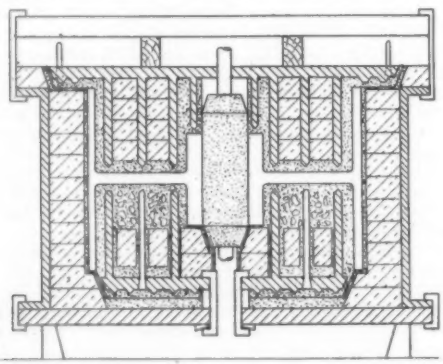


FIG. 2.—SECTIONAL VIEW OF COMPLETE MOULD.

the method of making may be somewhat different in regard to the inside; where, in this case, there are prods, in a large pulley brickwork and short-prodded plates would be used.

Fig. 2 shows a sectional view of the complete mould and tackle; Fig. 3 the mould board set for the outside; Fig. 4 the board set to strike a plain level surface; Fig. 5 the board set for the bottom half of the inside of the pulley; and Fig. 6 the board set for the top half of the inside pulley, and covering and closing in.

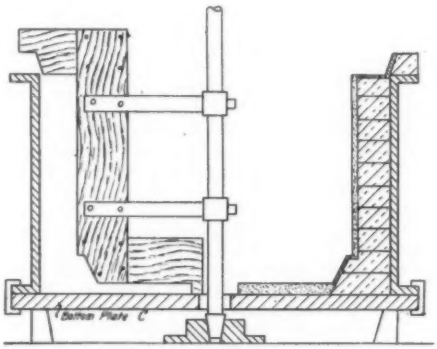


FIG. 3.—MOULD BOARD SET FOR THE OUTSIDE.

In Fig. 7 is shown plate A (Fig. 5) to carry the bottom part of the inside of thepulley; while in Fig. 8 is shown plate B (Fig. 6) to cover the pulley, with

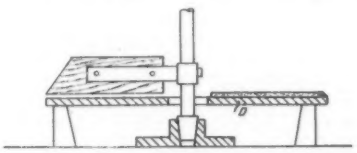


FIG. 4.—MOULD BOARD SET TO STRIKE LEVEL SURFACE.

runner gates and riser, and to carry the top half of the inside. Fig. 9 is the bottom plate (C, Fig. 3), while Fig. 10 is a sectional view of the mould before closing.

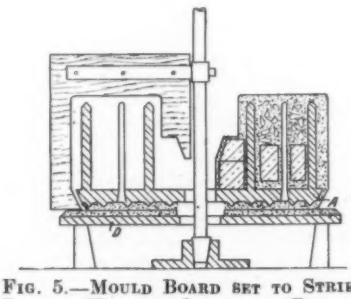


FIG. 5.—MOULD BOARD SET TO STRIKE BOTTOM HALF OF INSIDE OF PULLEY.

The procedure is as follows:—Level the bottom plate C; fix the cross and spindle; set the mould board to size stick (see Fig. 3), and proceed as usual

with the brickwork, roughing and finishing off. It will be noted that this board allows a layer of loam to strike on the bottom plate; this is to provide a true surface when dried for the bottom half of the

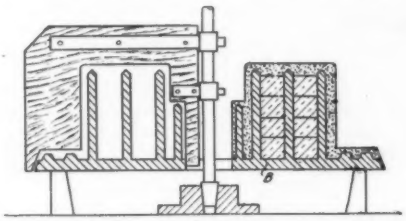


FIG. 6.—MOULD BOARD SET FOR TOP HALF OF INSIDE OF PULLEY.

inside to rest on (see Fig. 5), and also determines its true position. A guide is also made on the top plate B (see Figs. 2 and 6). The plain plate D is

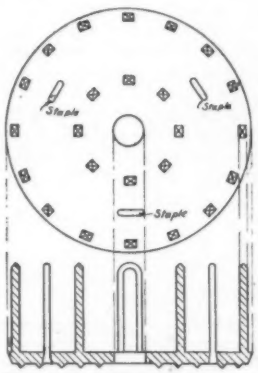


FIG. 7.—PLATE A (FIG. 5).

now levelled, and a thin layer of loam swept on, sufficient only to give a true level surface (see Fig. 4). When this is dried it forms a true surface

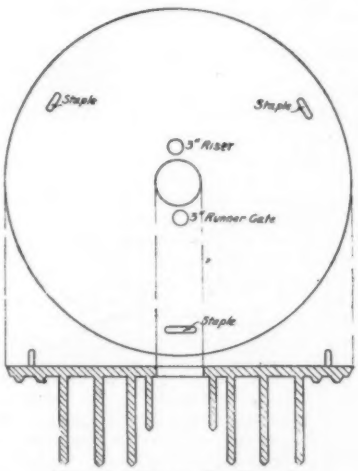


FIG. 8.—PLATE B (FIG. 6).

for a layer of soft loam to bed the plate A upon, and also a guide for the board which determines the length; the bottom of the board just clears the surface (see Fig. 5). Between the long prods, pieces of brick and coke daubed together with loam are filled in. When finished off with fine loam, the part is stoved on the plate D and lifted off when dried. It then forms the bottom half of the inside of the pulley (Figs. 2 and 10).

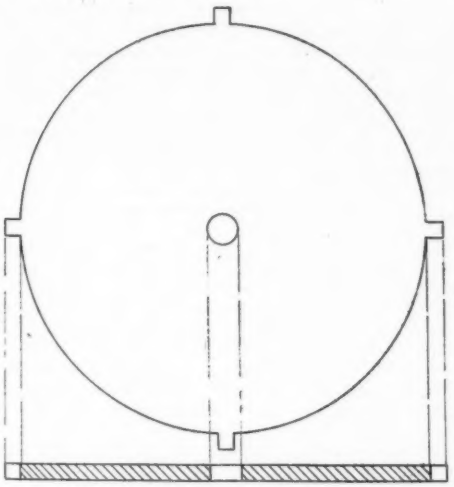


FIG. 9.—PLATE C (FIG. 3).

The top plate B (Fig. 8) is levelled, prods upwards; the spindle and cross are fixed, and the striking board set on the spindle (see Fig. 6). Between the long prods are fixed bricks, parts of bricks and cinders, daubed in with loam, then roughed over with loam, stiffened, and finished off with fine loam. When dried, dressed and washed with blacking, it is turned over and slung by staples

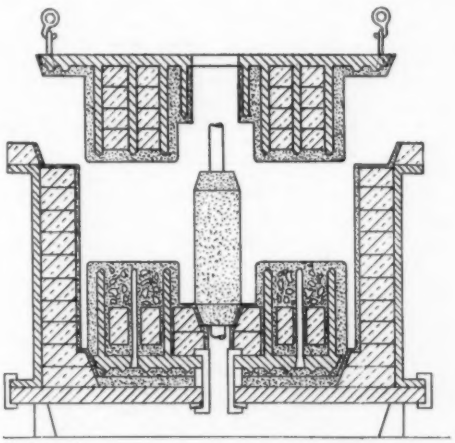


FIG. 10.—SECTIONAL VIEW OF MOULD BEFORE CLOSING.

cast in the plate, ready for closing (see Fig. 10). The runner gate and feeding riser are on top of the boss (Figs. 1 and 8), and small air-escapes, or whistlers, are on the top of the rim. The plate A (Fig. 5), which carries the part that forms the bottom half of the inside, is held down by small cramps.

How to Make a Single Saddle-Flange Pipe.

By J. H. Bingham.

A cheap and speedy method of meeting an order for a single odd-sized 24-in. saddle-flange pipe is described herewith. The labour entailed in the making of a pattern greatly adds to the initial cost of a casting, but the expense of producing a saddle pipe may be reduced to a minimum by striking up the mould in loam, thus doing away with the necessity for a wooden pattern.

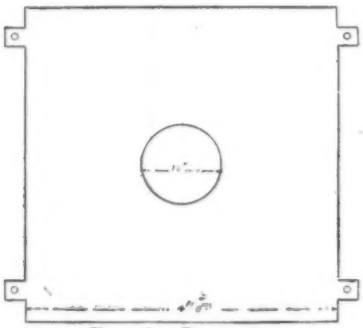


FIG. 1.—BEDPLATE.

A bedplate is cast 2 in. thick, and 4 ft. square, having a hole 1 ft. in diameter in the centre, and four handles arranged as shown in Fig. 1. This bedplate is then struck up with a straight-edge (Fig. 2) and dried. It may be noted that once the spindle cross has been clamped to the bottom plate, it must not be disturbed until the body-mould and core have been built. Two curved shear plates, cast to the outer radius of the saddle, are cramped to the bedplate, as in Fig. 3 (if a small casting is required wood plates may be substituted for the iron ones). The semi-cylindrical body is built up with bricks and loam, and strickled with a board which will allow for the thickness of the flange to

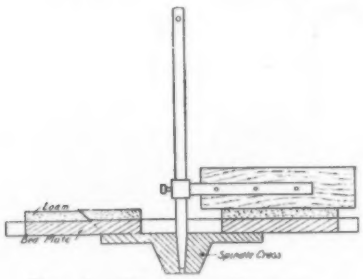


FIG. 2.—PREPARING BEDPLATE.

be added to this body, and so finish flush with the circumference of the shear plates.

Having thicknessed up the body, the spindle is replaced in position and the outline of the circular saddle flange is scribed on the body. This may be accomplished by holding the trowel against the board and sweeping out the required circle. That part of the thickness bounded by this circle is now removed, and the shallow hole thus formed is filled with sand, to prevent its being fouled by loam during the building of the body of the mould. A binder plate, having prods 12 in. long, is then fixed in position.

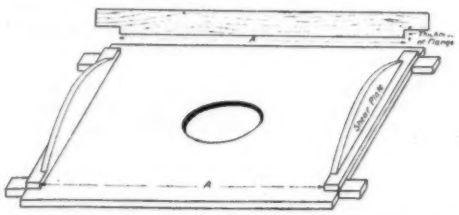


FIG. 3.—BEDPLATE WITH SHEAR PLATES IN POSITION.

The body mould is built up with bricks and loam. Provision is made on the striking board for sweeping out the flange (see Fig. 4). On completion the body mould is removed and put into the stove to dry.

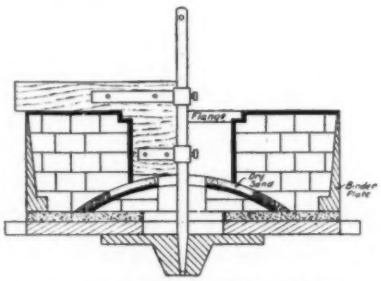


FIG. 4.—BUILDING BODY MOULD.

Meanwhile, the core may be built up. The core-board is fixed to the spindle and the core erected on the semi-cylindrical body on the bottom plate. If a large pipe is being built a moveable extension

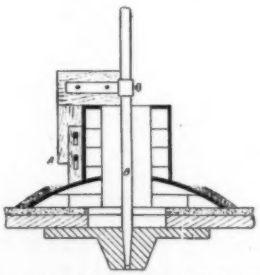


FIG. 5.—SHOWING BUILDING OF CORE AND CORE-BOARD EXTENSION.

piece may be fitted to the core board to facilitate the striking of the lowest part of the core on the curved saddle flange (see Fig. 5), as the lowest

point A of the core-board must be in the same horizontal plane as B, the highest point on the cylindrical body, that is after part of the dry sand has been removed from the saddle flange.

The top plate is cast the same size as the bottom plate, with a central hole and four circular runner holes and two similar ones for risers arranged as shown. Small prods about an inch in length should also be cast on the plate to hold the loam. After sufficient drying, the mould may be assembled. The top plate should be secured to the bottom one by long cramps from handle to handle, after which everything is ready for casting.

The Foundry and the Drawing Office.

By Owen Linley.

In many engineering establishments there is always something in the nature of feud proceeding between the drawing office and the shops, the men who rule the latter complaining of want of practical experience on the part of the draughtsmen. All practical men know that a large saving can often be effected by attention to certain details which are often overlooked by the draughtsman, and this

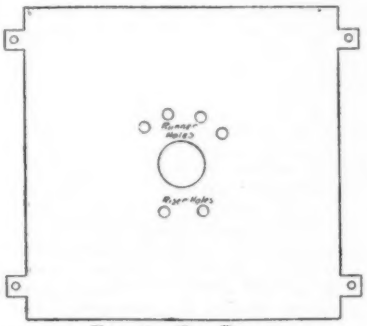


Fig. 6.—Top Plate.

applies to the machine shop as well as the foundry. The writer holds no brief for any particular department. It must be remembered that while the present-day draughtsman is supposed to possess an amount of theoretical and scientific knowledge, the acquirement of which must at the beginning of his career occupy the greater part of his time, some draughtsmen have no opportunity of learning anything concerning foundry matters.

Some firms who have no foundry and rely on getting their castings from outside sources, know little of foundry requirements. To give an instance, the writer recently saw a young draughtsman making a drawing of a rather large and slender frame that had some deep draws on it. It was evident by the way that he was going about it that it would give some trouble to the moulders, and on questioning him as to his knowledge of these matters he admitted that he had never been inside a foundry in his life. Many draughtsmen only obtain their experience from other draughtsmen, and not directly from the practical source, namely, the shops. They thus acquire a kind of parrot-like knowledge that is often very misleading. Then again, some draughtsmen seem to have a strange conception of their duties and think it concerns them but little as to how the work is actually going to be produced.

It is not much use pointing out evils unless remedies can be indicated. To begin with, the head of a firm or the chief engineer should encourage greater harmony between the various departments. It often happens that a few minutes discussion between the draughtsmen, the foreman moulder and the pattern-maker, and in some cases those in charge of the machine shops, can be the means of saving a considerable amount of money.

To return to the foundry, it is a somewhat curious thing that when it is contemplated sending a young man through the shops, the foundry is generally omitted, although this is really the place that he should start from. There is no need for him to actually work as a moulder, but he should certainly know how the different classes of patterns are got out of the moulds, how metal is poured and how it flows under various circumstances so that a sound casting can be obtained. When he has acquired some knowledge of these matters, even if it is only very slight, he will be much better able to follow what goes on in the pattern shop. He will now understand why patterns are constructed on certain methods, and this knowledge should be of service to him later on when designing the frame of a machine. Under the present conditions, what really happens is that many a draughtsman acquires this knowledge backwards. In fact, many draughtsmen never seem to grasp quite as they should, what the requirements of the foundry really are, and this also extends to some extent to the pattern shop.

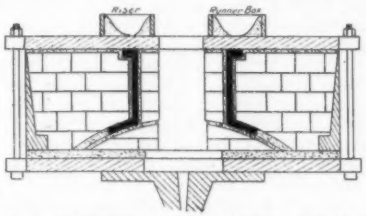


Fig. 7.—Assembled Mould Ready for Casting.

Apart from the manufacturing aspect of the matter, a knowledge of what goes on in the foundry, coupled with some, even though not very extensive, experience of pattern-making, is often very valuable in out of the way places, the Colonies, etc. Young engineers who contemplate going abroad should bear this in mind.

Large Electric Steel Furnace.

A contract has been made by the American Iron and Steel Manufacturing Company, of Lebanon, Pennsylvania, for the construction of an electric steel furnace installation, which it is believed will be the largest in the world, the order having been booked by Messrs. Siemens & Halske, of Berlin. The plant is to consist of two 20-ton induction furnaces of the Frick double-ring type, which will be run on five cycles, single phase, with a current of about 5,000 volts. As the power requirements of the furnaces will be 1,800 kilowatts each, two new generators will probably be installed by the company. The new furnaces will refine liquid steel, which will be taken from a group of four 50-ton open-hearth furnaces now under construction. The refining capacity will be from 10 to 20 heats, or from 200 to 400 tons daily. The steel produced by this process will be rolled into billets. It is expected that the electric furnace installation at Lebanon will be completed and put in operation during the latter part of 1914.

Stucco Patterns.*

By R. R. McGowan.

Perhaps the class of trade to which stucco may be said to be most suitable, is that known as the hollow-ware trade, including pipes, gutters, and light castings generally. The usual method, when numerous castings are required, is to make a metal pattern from the stucco, but in many cases when only one casting is required it may be made direct from the stucco. As an example of some of the methods adopted with "shell" patterns, or patterns which leave their own core, prior to the use of stucco, may be taken a pattern for a quarter bend with the usual faucet and spigot joints (see Fig. 1). One of the former methods of producing a pattern such as this was to make a wooden block to the exact size and shape of the core, jointed at the parting line. This wooden block was covered with sheet-lead to the thickness of metal required, this necessitating much cutting and soldering. A wooden pattern was turned in the lathe to the shape of the faucet and spigot, leaving a print or bearing, as shown in Fig. 2. A mould was then taken from this, and after the pattern was withdrawn from the mould, it was again placed in the lathe and turned down to the shape of the core (see Fig. 3). This wooden core, after being sand-papered, was faced with chalk to give a good surface to the inside of the lead pattern, lead being the material with which it was cast. This was again placed into the mould and formed the core as indicated by dotted line on Fig. 2. After being cast in lead it was cleaned up, cut in two and the wooden core removed, keeping one of the parts full. This was afterwards faced up with files to the exact half, and the pattern for the faucet and spigot was complete. These halves were kept as original patterns; two halves were cast from each, and soldered on to the sheet-lead already referred to, which formed the body of the pattern under consideration. Iron patterns were then made from each half, fitted and filed up in the usual way, making the complete shell pattern.

Another method adopted in some foundries was that of making a complete solid pattern in wood with bearings at the ends and a core-box to suit. These most expensive methods of pattern-making have been entirely superseded by the introduction of stucco. In making the same pattern in stucco, the following methods would be adopted. Two gauges are required with semi-circular openings, one cut to the inside and the other to the outside diameter of the pipe. Fig. 4 is the block or core gauge, and Fig. 5 the outside or thickness gauge, these two gauges being similar in all other respects except the diameter of the opening. These gauges are usually made of sheet malleable iron or from a thin plate of cast iron, the half-round face being chamfered away at the back as shown on the enlarged sketch, Fig. 6, leaving not more than $\frac{1}{32}$ in. on the cutting face. After being filed to the diameter, this face must be finished with emery paper and made perfectly smooth.

A wooden laying-down or turning-over board is now required, a little larger than the pattern to be made, also a thin piece of wood, about $\frac{3}{16}$ in. thick, cut to the contour of the pattern; this guide or guard strip is secured to the board. Fig. 7 shows the board, guard strip and gauge ready to receive the soft stucco, which is laid on the track of the gauge as indicated by dotted line. The gauge is then moved along the edge of the guard strip, the stucco "built up" until the block or core takes the exact shape of the gauge as shown in Fig. 8.

This block now receives a coat of shellac varnish, and when dry is given a coat of oil. The oil is to the stucco worker as parting sand is to the moulder; it allows the thickness when "run up" to part from the block, and the use of the varnish on the block is to form a surface on the stucco through which the oil cannot penetrate. Fig. 9 shows the outside gauge ready to sweep up the soft stucco which is to form the thickness: this gauge is moved along the edge of the guard strip, in the same way as the block gauge, and the soft stucco built up until it takes the form of the gauge.

The method of stucco work just described is called guard work, and is by far the most commonly used. It will be observed that the stucco might be made to take practically any shape; all that is required is to make the guard strip to the required form, and work the gauge along it.

We have now to deal with the faucet and spigot. In all foundries, however, where there is a "run" of this class of work, original patterns of faucets and spigots are kept in stock, for all the standard sizes of pipes made, and when the stucco is run up it is only a matter of setting these faucets into position to complete the pattern. The same remark applies to the gauges. In all well-appointed hollow-ware foundries there are in stock gauges to suit all the standard sizes of pipes. The patterns of the faucet and spigot involve another form of stucco work called spindle work. A spindle is erected on trestles as shown in Fig. 10, and pins are put in the spindle at intervals to prevent the stucco revolving except with the spindle. A gauge is then placed on the trestles cut to the shape of the core of the faucet and spigot, and secured at a distance from the centre of the spindle, to give the required diameter. Tarred rope, or any other cheap material, is wound round the spindle to within a short distance from the edge of the gauge; the soft stucco is then built on the tarred rope, and as the spindle is revolved, the soft stucco is formed into shape by the fixed gauge. When the block or core part is finished the gauge is removed and the "hatched" part shown on Fig. 10 is cut out of the gauge. A small "V" groove is cut in the block to prevent the thickness revolving except with the block, and after this is done the block is varnished, then oiled, and the gauge is again placed into its original position and the thickness run on. When finished only a half-pattern of each is used; from these original patterns are cast and stocked ready to place on any pipe connection which may be run up.

Another form of machine for stucco work is that known as the vertical spindle (see Fig. 11). This is more applicable for work of larger diameters than is the horizontal spindle; all the parts are stationary except the frame that secures the wooden gauge which revolves. The sketch shows a pattern for a cast-iron base run up ready to cut off.

Another method of sweeping up stucco is that known as "centre work." The centre from which

* Abstract of Paper read before the Scottish Branch of the British Foundrymen's Association.

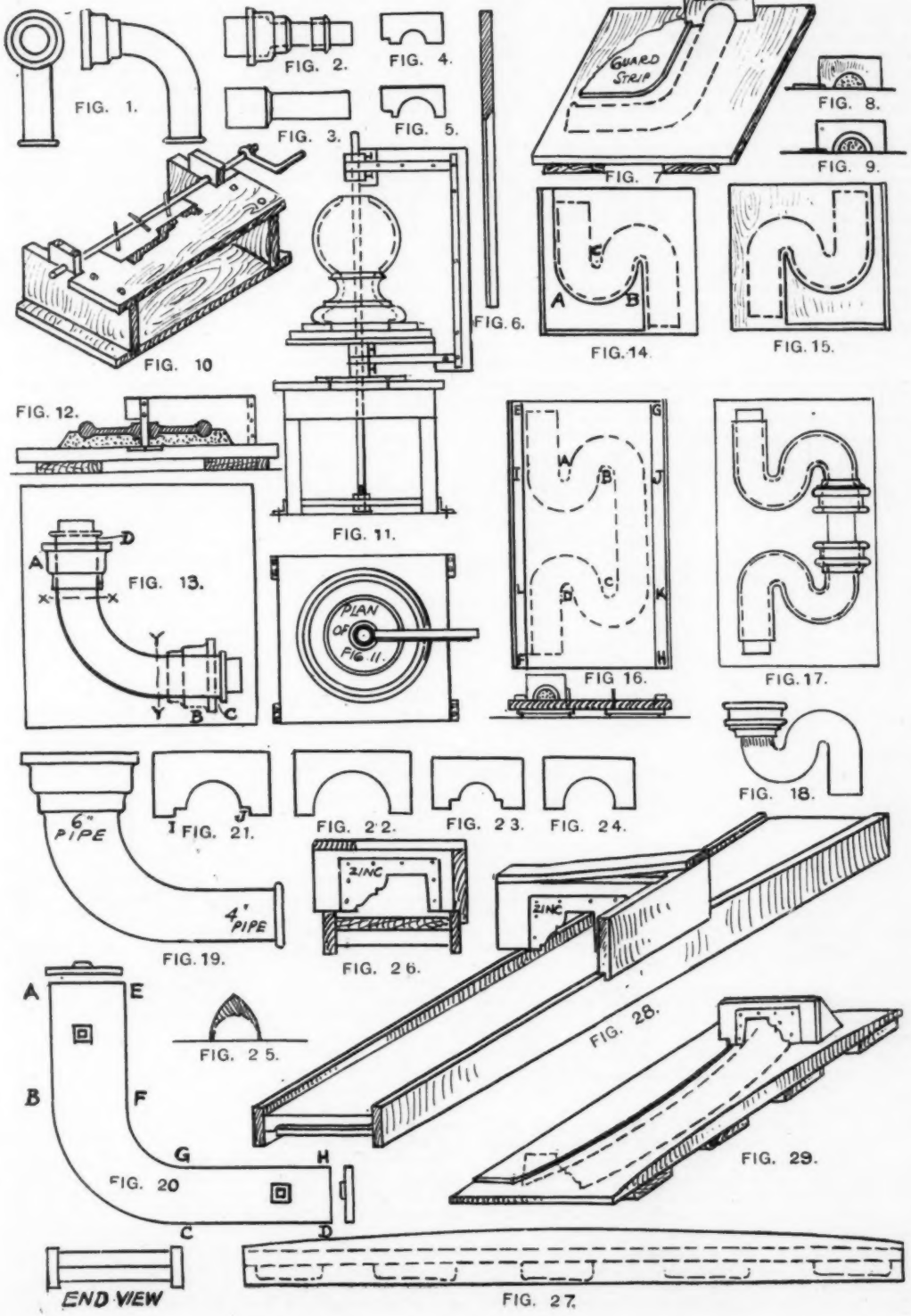


FIG. 1.
FIG. 2.
FIG. 3.
FIG. 4.
FIG. 5.
FIG. 6.
GAUGE
GUARD STRIP
FIG. 7.
FIG. 8.
FIG. 9.
FIG. 10
FIG. 11.
FIG. 12.
FIG. 13.
PLAN OF FIG 11.
FIG. 14.
FIG. 15.
FIG 16.
FIG. 17.
FIG. 18.
6" PIPE
4" PIPE
FIG. 19.
FIG. 20
FIG. 21.
FIG. 22.
FIG. 23.
FIG. 24.
FIG. 25.
FIG. 26.
ZINC
FIG. 27.
FIG. 28.
FIG. 29.
END VIEW

this method derives its name is a small plate about an eighth of an inch in thickness, with two holes countersunk for screws and one hole in the centre. The plate is then sunk into the board on which the stucco is to be run up, making the top of the plate to line with the face of the board. In this centre hole works a spindle which is flattened at one of the ends, and prepared with holes for securing to the revolving gauge. Fig. 12 shows a small wheel run up by this method; the gauge is first cut to run up the block, and afterwards cut as shown to give the thickness. When a good face is wanted on the stucco or when there are some features requiring sharp lines, the gauge should be made of zinc, as nothing gives a better line or finish than a zinc gauge.

Before considering a rather unique method of making patterns for the syphon bend shown in Fig. 18, we may first consider the method usually adopted. Fig. 14 shows a laying-down board with guard strip in position; the track of the gauge is stucco is placed on the track of the gauge, which starts at E and drawn along the edge of the strip EF to I when the other edge of the gauge comes against the side of the pin A, when it is held against it and revolved until the other edge comes against the pin B; the gauge is then revolved on the pin B until the edge which revolved on pin A comes against the edge of the strip GH at J. The gauge is then drawn along the strip from J to K, when it is revolved on the pin C and then on pin D, and again on to the edge of strip EF at L; it is then drawn along the strip and finished at F.

When the thickness has been run on, the ends are faced to the proper lengths, and the faucets placed in position; the pattern is then ready to pass to the moulder for the iron pattern, as shown in Fig. 17.

Even in work where circumstances do not permit using the latter method, the principles can be combined with the former method by having a pin fixed temporarily at the centre of both the internal and external curves, and when the work at these parts

Table of Camber for Work of a Channel Section.

NOTE.—The figures given are for patterns 6 ft. 0 ins. long, on which there are two contractions allowed. The patterns from which the castings are made should have HALF the amount given in the table.

Depth of Channel in Inches.	Metal 1/8" Thick.	Metal 5/32" Thick.	Metal 3/16" Thick.	Metal 7/32" Thick.	Metal 1/4" Thick.	Metal 5/16" Thick.	Metal 3/8" Thick.	Metal 7/16" Thick.	Metal 1/2" Thick.	Depth of Channel in Inches.
	Camber.	Camber.	Camber.	Camber.	Camber.	Camber.	Camber.	Camber.	Camber.	
1½"	1½"	51/32"	37/64"	53/64"	25/32"	31/32"	33/64"	39/64"	3/8"	1½"
2"	65/64"	15/16"	55/64"	51/64"	3/4"	5/8"	23/64"	7/16"	23/64"	2"
2½"	51/32"	57/64"	13/16"	49/64"	23/32"	29/64"	1/2"	27/64"	11/32"	2½"
3"	59/64"	27/32"	53/32"	23/32"	43/64"	9/16"	15/32"	25/64"	21/64"	3"
3½"	7/8"	51/64"	47/64"	11/16"	41/64"	25/64"	29/64"	3/8"	5/16"	3½"
4"	53/64"	49/64"	45/64"	21/32"	39/64"	23/64"	27/64"	23/64"	19/64"	4"
4½"	25/32"	47/64"	21/32"	39/64"	9/16"	21/64"	13/32"	11/32"	9/32"	4½"
5"	47/64"	43/64"	5/8"	37/64"	37/32"	29/64"	3/7"	5/16"	17/64"	5"
5½"	11/16"	5/8"	37/64"	17/32"	1/2"	27/64"	23/64"	19/64"	1/4"	5½"
6"	41/64"	19/32"	33/64"	1/2"	29/64"	25/64"	21/64"	9/32"	15/64"	6"
6½"	19/32"	35/64"	1/2"	29/64"	27/64"	23/64"	5/16"	17/64"	7/32"	6½"
7"	35/64"	1/2"	15/32"	27/64"	25/64"	21/64"	9/32"	15/64"	13/64"	7"
7½"	1/2"	29/64"	27/64"	25/64"	11/32"	19/64"	17/64"	7/32"	3/16"	7½"
8"	29/64"	27/64"	25/64"	11/32"	5/16"	17/64"	15/64"	13/64"	11/64"	8"
9"	13/32"	3/8"	11/32"	5/16"	9/32"	1/4"	7/32"	3/16"	5/32"	9"

indicated by dotted line. This is one of the most difficult patterns to be made by the pattern-maker, as there is an internal curve A to B to be overcome. In working round this curve it is hardly possible to get a true curve at the point C, and when running on the thickness there is every chance of it tearing off at that point. In making the reverse hand, the guard strip is removed from its present position, turned upside down and fixed on to another board as shown in Fig. 15. The faucets are then added to each half, and the pattern is ready to pass to the moulder.

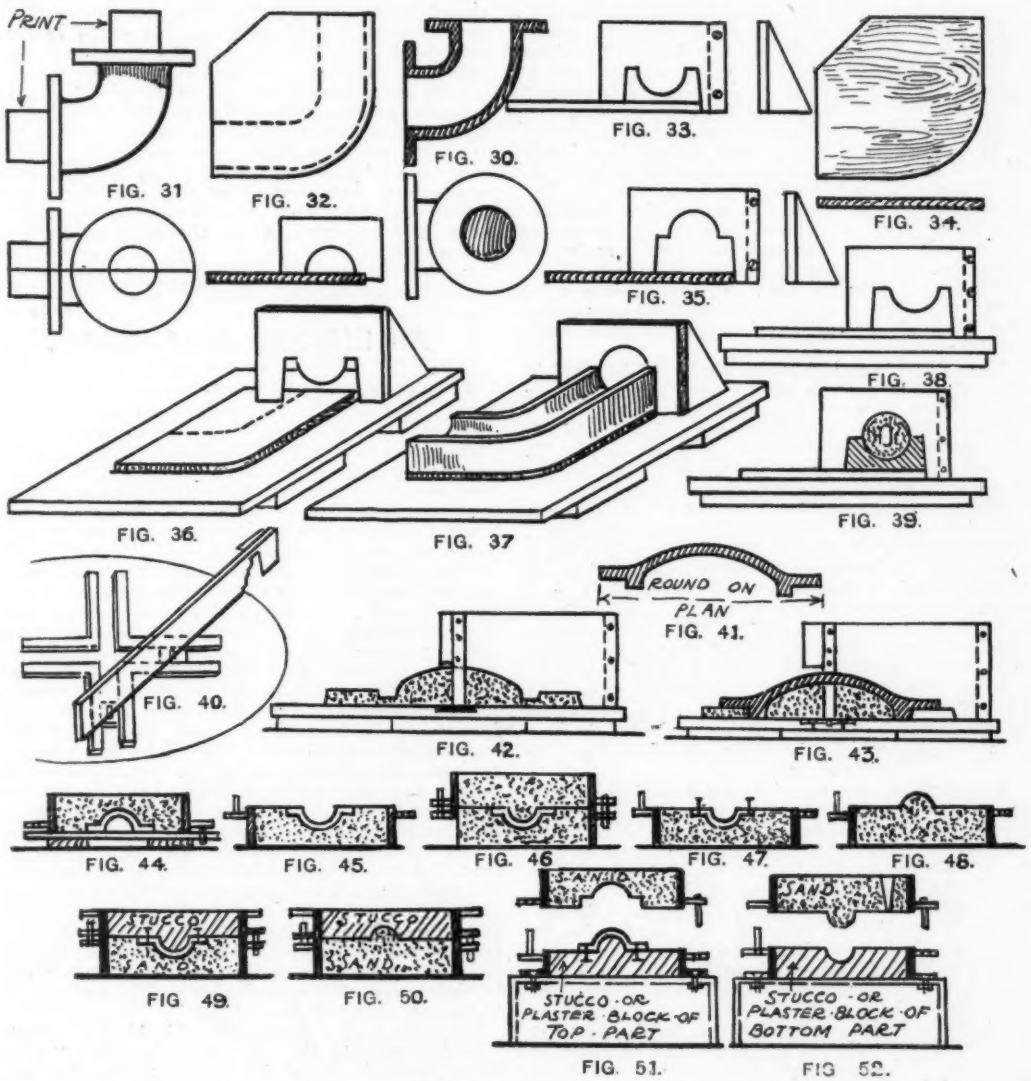
There is another method by which not only can both halves of the pattern be run up at the same time, but the trouble of the internal curve entirely disappears. The iron gauges and the laying-down board are required in this as in the other method. Two halves (right and left) of the syphon bend are drawn down on the laying-down board (see Fig. 16). Two strips EF and GH are secured to the board, and pins, say, ¼ in. in diameter, are fixed into the board at the centres, A, B, C and D, leaving a part projecting about 2 in. outside the board. The soft is finished the pin is removed to allow the gauge to pass on to the remainder of the work.

In the case of syphon bends, offsets and similar work, it is necessary to make two separate half-patterns, right- and left-hand. With pipe bends the reverse hand may be obtained from one pattern by the interchanging of the faucet and spigot (see Fig. 13). A joint is made in the thickness only at the points marked X X and Y Y; a casting is first made from the pattern with faucet at A and spigot at C, after which the faucet at A is removed to B and spigot C to D; this reverses the pattern and thus makes the complete pattern when both halves are brought together.

With regard to the pattern of a tapered or reducing bend (Fig. 19), this is one with which few pattern-makers have not at some time or other found a difficulty in deciding the best means for its construction. Stucco overcomes the trouble in the following way:—As already explained, the faucet and spigot are dealt with separately, therefore the only part with which we are concerned meantime is the plain part or body of the bend. Assuming

that the bend tapers from 6 in. to 4 in. and the thickness of metal is ⅜ in., a template is made to the plan of the bend (see Fig. 20), say, about ½ in. thick, the part A E to B F being 6¾ in. wide and C G to D H 4¾ in. wide, the part B F to C G varying from 6¾ in. to 4¾ in. This template is secured to a laying-down board and four gauges made, as shown in Figs. 21, 22, 23, and 24 respectively. Figs. 21 and 23 are the block gauges and Figs. 22 and 24 are the outside gauges. The soft stucco is built up on the top of the template Fig. 20, and with the gauge, Fig. 21, the stucco is swept into shape, the check J being drawn along the inner curve of the template from E to G; then the same guage, but with the check I, is drawn along the outer curve from A to C. The outer gauge, Fig. 23, is used to finish the remainder C G to D H.

When this operation is complete and the stucco has "set" the block from A to B will be 6 in. parallel, from C to D 4 in. parallel, and from B to C the sides varying from 6 in. to 4 in.; at the point C G where the 6-in. gauge finishes the shape of the block will be as shown in Fig. 25. This requires to be reduced by hand to its correct form, shown by dotted line on the same sketch. When this is done the block is varnished, then oiled, and is ready for the thickness, which is treated in a similar manner to that already described, but using the gauges Figs. 22 and 24 respectively. When finished the whole is removed from the top of the template and placed on another laying-down board, and when the faucet and spigot are added one-half of the pattern is complete. To produce the other half the template is removed from its present position, turned upside down, secured to the laying-down board and the stucco run up on this side in the same manner as already described. The faucet and spigot are added and the whole pattern is then complete.



Patterns of channel section involve a system of stucco work known as track work. In the first place two zinc gauges are required, one cut to the shape of the inside and the other to the shape of the outside of the required section, and these are screwed on to a wooden frame as shown in Fig. 26. A laying-down board is required a little longer and broader than the size of the pattern, and on to each side of this board is secured a strip about ¾ in. thick and from 3 in. to 4 in. deep; the top edge of each is curved to the amount of camber required on the pattern (see Fig. 27 and Table of Cambers). This table of cambers has been compiled by the writer to assist those who have to deal with patterns requiring camber; the type of work we are at present discussing belongs to that class. The cambers are for patterns of equal metal throughout, i.e., without beads or swellings at the edges.

The laying-down board is now secured to a bench, the soft stucco is laid on and the gauge moved along until the work is brought into shape (see Fig. 28). When the block is complete it is varnished, oiled and the inside gauge is removed from the frame, leaving the outside gauge. The same operation is performed with the outside gauge, which now runs on the "thickness." The thickness in long patterns is cut into parts about 1 ft. long to facilitate moulding. The work when varnished is ready to pass to the moulder.

The foregoing has only dealt with straight channels. The pattern of a circled channel is run up similarly to that of a pipe bend; a template is made to the curve, and the gauge is held against it and worked round its contour, as shown in Fig. 29. Circled channels require to be cambered in the same manner as patterns for straight channels.

We may now consider the use of stucco as a material with which to make temporary core-boxes. The example illustrated is that of a core-box for a pipe bend, Fig. 30. Foundries specialising in "pipe work" have patterns to leave their own cores, but in engineering works the practice is to make a solid pattern (see Fig. 31). To produce a core-box in wood for a pipe bend is most expensive; to clay out the thickness is also expensive, and to run up two half cores by the method shown in Fig. 32 and tie them together is not a very satisfactory method. The alternative suggested is that of making the core-box in stucco, shown in Figs. 33, 34, 35, 36, 37, 38, and 39.

A method of dealing with stucco patterns which are elliptical in form is by means of an apparatus founded on the instrument known as the elliptical compass (see Fig. 40). A further example of the use of stucco in the foundry is that of casting stucco into sand moulds and using the stucco casting as a pattern. The example taken here is one commonly practised in some foundries, and refers to the production of castings such as cylinder covers (Fig. 41). This is a type of casting, the mould for which is usually produced by guide work: the guides are made to the form of the casting and secured to a spindle and the sand swept out to the form of these guides or strickles. If more than one casting is required it is found more economical to sweep up the mould in the usual way and cast a stucco pattern from the mould thus formed and then make the other castings from the stucco pattern. Of course, it would be very much better practice for the pattern-maker to make a stucco pattern in the first instance (see Figs. 42 and 43), a method which I believe will be adopted when the use of stucco becomes better known.

The use of plaster blocks in machine-moulding practice is another example of the application of stucco to foundry practice. As is well known, the object of machine moulding, like plate moulding, is to obviate the necessity of making a parting to the mould. Now, plaster blocks allow of moulding by machine castings which otherwise it would be impossible to make. Briefly, the process is as shown in Figs. 42 to 52. The idea of plaster blocks is just a false top and a false drag, and a mould made from each when brought together forms the complete mould. The moulding boxes, of course, in this system, as in all other types of machine moulding, must be interchangeable with a master box. I am surprised that the idea embodied in this system is not more largely taken advantage of in ordinary practice, as it is just as applicable to hand moulding as it is to machine moulding.

In ordinary practice, using boxes which are not interchangeable, where a false top is required, there is nothing suits the purpose better than a false top made of stucco; partings of the most intricate nature can be made on a stucco false top, and drags rammed on a top made of this material require practically no finishing prior to applying the parting sand necessary to separate the different parts of the mould.

An Efficient Sand Binder.

In no class of skilled industry is the statement that "the old order changeth" more notably exemplified than in the founders' craft. Owing to the excellence of the craftsmanship demanded, and the scientific knowledge which is necessary for the production of perfect castings, these changes are of vital importance, as they affect every foundryman who wishes to be recognised as a "live" factor in the industrial world. It is within the knowledge of the present generation that many castings a few years ago would have been considered impossible of execution and beyond reason, both for size and design, but are to-day looked upon as nothing beyond the ordinary. Although much has been learned and many new ideas evolved, the field still open to invention, with its consequent economising results, is still vast. One point of paramount importance is a suitable sand-binding material, which must be applicable to all grades and mixtures of sands, for all classes of work. Sand binders, of course, are not new to the foundryman, but the claims of the material known as "Binderit" to be an efficient, economical sand-binding material which possesses the desired porosity while still maintaining that rigidity so highly desirable and necessary for the production of cores, are well worthy of attention. In the claims of this material—which the tests that have come before us appear to thoroughly support—an outstanding feature is that cores formed of a 75 per cent. pure silica can be handled freely whilst in their green state and during drying are not apt to become distorted or to shrink.

When used as a blackwash, this binder imparts a perfect skin to the casting, giving that "art" bloom which is the delight of every founder and user of castings. When combined with facing sand the flaking or scabbing of the latter is entirely obviated, and castings free from scabs are produced. "Binderit" is a water-soluble sand binder and claims to be an absolute substitute for oil or oil compounds, and it is suggested that in this respect, owing to fluctuating prices of oil, it affords advantages of economy to the founder. Further information in regard to the material may be had from The British Binderit Company, Limited, Southampton House, 317, High Holborn, W.C.

Correspondence.

The Foundry and the Drawing Office.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—With reference to your comments on page 13 of last month's "Journal" upon the foundry and the drawing office, I note that you, to all intents and purposes, taboo the value of perspective drawing as an aid to the foundryman for the conception of a portion of mechanism. As your comments deal with the value of a drawing in the hands of a practical man, then obviously it becomes a question of apportioning the relative values of perspective drawing and solid geometrical representation. I use the term "solid geometrical representation" advisedly, as it is also to be noted that you refer to perspective drawing as not being mechanical drawing. With all courtesy I must correct you upon this point, as linear perspective—often termed "architectural drawing" can be mechanical drawing, and is, as a matter of fact, worked out correctly with mathematical instruments; but it differs from the popular idea of machine drawing in the respect that it gives to the mind the image as conveyed by the eye. Machine drawing, on the contrary, is the outcome of certain rules wherein the eye becomes purely subservient to the mind.

Considering comparative values between these two methods, from the foundryman's point of view, is it really necessary for the foundryman to be able to understand, or "read," a three-view machine drawing? Admitting the advantages derived, owing to its being the common and accepted means of conveying a machine's representation, I personally take the view that as the foundryman is not directly responsible for size, form, etc., it is for him unnecessary. Owing to the foundryman being provided with a means (as a pattern) for producing castings, the shape, form, size, etc., for any of which he is not directly responsible, wherein does the advantage lie, assuming he could read the drawing? If the castings proved to be incorrect in any of the ways stipulated, it is very questionable if he could rectify further replacements even by the aid of a drawing and without the alteration of the pattern. As already mentioned, the onus not being upon him, why should he trouble about another's oversight."

If the view be taken that a knowledge of the drawing would have prevented any of these errors, then it follows that with every pattern supplied a drawing should also be given, and thus it becomes a question of the moulder overlooking the pattern-maker's work in these respects. This, of cource, would not only be absurd, but ridiculous, and no further comment is needed.

Taking now the advantages of a perspective drawing, this being the natural representation requires no training to understand, and is thus more quickly grasped. This method is the workshop method for readily explaining portions of work, but it is known by the more homely term of "a bit of a sketch." If it be done neatly, with a knowledge of perspective laws, it will convey to the mind the objective more clearly than is possible by the three-view method, even to those who are thoroughly acquainted with this latter.

A perspective drawing, if it is at all complicated, does not allow of every dimension being clearly indicated, but who would dream of placing all dimensions upon, for example, the general arrangement drawing of a steam engine, which type of drawing is generally the "one" view of a so-called mechanical drawing. In the majority of cases the perspective drawing allows sufficient for a comprehensive dimension scheme, and as far as the foundryman is concerned more than enough, as he would only require overall dimensions to make provision for moulding, and for taking into consideration any metal strains or stresses that might be the outcome of the general design, minor details being obtained from the patterns, core boxes, etc.

From the point of view of the pattern-maker and draughtsman the three-view method is an obvious necessity, as every portion has to be previously studied for production; but this complete machine-drawing recognition is, in the writer's opinion, quite unnecessary for the average foundryman, and if a perspective drawing be supplied it will satisfy all his requirements more expediously and in a far simpler manner than any machine drawing of the three-view variety can possibly hope to do.

Yours, etc.,

Poplar, D. GORDON.
London, E.,
January 8, 1914.

[Before dealing with some of the important considerations which our correspondent has overlooked, we invite the opinion of readers interested in the subject.—The Editor.]

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In your January issue, which contains a Paper on "Cast Iron," by Mr. F. J. Cook, on page 44 is given a formula which is distinctly interesting. I have met these formula before, but have never been able to make them fit in with actual practice. On Saturday last there was sent to me from a foundry laboratory, an analysis of pig-iron which contained total carbon 3.26 per cent. and silicon 1.07 per cent. According to Mr. Cook's formula the combined carbon should be 0.83 per cent.; actually it was 0.56 per cent. Of course, Mr. Cook's formula may possibly be applicable to irons obtained from certain works, or even in certain districts where the morking is similar, but as showing the difficulty of working on formula the following tables may be interesting, taken from one of my Papers given before the West of Scotland Iron and Steel Institute:—

A.		B.	
Combined carbon.	Silicon.	Combined carbon.	Silicon.
Trace	3.12	0.54	1.81
0.25	2.90	0.57	3 11
0.35	1.23	0.60	2.36
0.35	2.52	0.60	2.51
0.36	1.52	0.60	3 05
0.44	2.23	0.62	3·19
0.50	1.64	0.62	3.50
0.51	1.75	0.63	2.33
0.52	1.65		
0.54	1.31		
0.58	2.19		
0.66	1.82		
0.70	0.98		

A. gives the combined carbon and silicon contents of test bars from different irons. B. gives combined carbon and silicon contents of pig-irons.

Under no conditions of working can silicon control the percentage of combined carbon. This has several times been emphasised in my Papers. Both total carbon and combined carbon depend upon conditions quite outside of chemical contents.

Yours, etc.,

E. ADAMSON.

Sheffield,
January 19, 1914.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—May I be allowed to endorse the remarks of Mr. J. Mathews, made at the opening meeting of the Newcastle Branch of the British Foundrymen's Association on the discussion of "Openings for Foundry Progress," and duly reported in the January issue of THE FOUNDRY TRADES JOURNAL. Mr. Mathews suggested that founders in the North of England should unite with the obect of trying to obtain a local moulding sand capable of fulfilling their general requirements, as the question of carriage plays a prominent part in the selection of their raw materials.

If founders in the North of England were to unite in this matter and by concerted action grant a subsidy to defray the cost of the necessary research work, it would be quite possible to determine the value of each local moulding-sand deposit at a reasonable cost, if tested collectively. If such deposits had to be tested individually however, it would increase the cost of such work out of all proportion.

Yours,etc.,
ALGERNON LEWIN CURTIS.

Chatteris,
January 17, 1914.

Queries.

Swept Core Barrels for Steel Castings.

Reply to Query in January Issue.—This method is in constant use in many steel foundries. Its success depends upon the construction of the core and the materials used therein. If the inquirer will send me full particulars of his trouble I will endeavour to help him.

ALGERNON LEWIN CURTIS,
Chatteris, R.S.O.

Reply.—As a steel moulder, I have had a great deal of experience with cores made of steel loam, both in England and the United States of America, but it is difficult to advise without knowing the thickness of the metal around the core and the position of the core in the mould during casting. If your correspondent will communicate with me I will advise him on the matter.

W. J. SIMCOCK.
15, Guide Street, Weaste, near Manchester.

Tar Sand for Steel.

Reply to Query in January Issue.—We are informed that Messrs J. & J. Dyson, Sheffield Gannister Works, Attercliffe Road, Sheffield, are makers of a tarred sand for steel moulding, called "Pehrson's Greensand."

Reply.—The mixing of tar-sand for steel depends entirely upon the sand, and as there are several thousand varieties of the latter, all of which possess distinct individualities at the temperatures molten steel is teemed at, it would be impossible to pass an opinion without first examining the sand intended for use. Just mixing tar with an ordinary moulding sand would not pay for the cost of the experiment. Also, as tar is not the best form of hydrocarbon to use, besides being obnoxious to the moulders in consequence of the fumes it gives off, it would not pay to prepare a mixture which can be made more economically by other materials. If the enquirer will write to me I will try to assist him.

ALGERNON LEWIN CURTIS,
Chatteris, R.S.O.

British Foundrymen's Association.

Lancashire Branch.

The sixth annual dinner of this Branch was held at Manchester on January 10. Mr. J. Simkiss (Branch-President) was supported by Mr. S. A. Gimson (President of the Parent Association) and a record gathering of members.

MR. GIMSON, in proposing the toast of "The Lancashire Branch," said he had a great admiration for their county, which was regarded as the centre of the engineering trade, and as a centre of light and leading in many other things as well. He congratulated them on belonging to one of the most successful and active Branches in the Association, and though in point of numbers Birmingham stood first with 176 members, he believed that Manchester was stronger financially. The Association was trying to give the members a special kind of education, by affording them facilities for educating themselves. When a man once thought he had finished his education that man was done for. Every man should begin his education from the first day he went to school, and continue it until the day of his death. Prof. Bryce told them that he had noticed in his travels in America, in the Colonies and elsewhere, that Englishmen were getting the reputation of not being fond of study. That was a very serious thing, especially as in higher education, technical education, we were being left behind by Germany and America. In America every town of the size of Leicester, in which he lived, had its own university, but it was not the case in England, where they are few and far between. A Professor at the Manchester University had stated, that whereas 12 years ago their laboratories were equal to those in German universities, now in some of the schools in Germany, to say nothing of the Universities, they had laboratories which those in Manchester could not touch. If England was to maintain her position, we must have as fine educational institutions as they had in Germany and in America. (Hear, hear.) The Association was doing good work by means of the lectures given and the discussions which took place at the monthly meetings of the Branches and at the annual conventions. But they must endeavour to do a great deal more than they had done, especially in trying to secure for the foundrymen the best possible training. (Hear, hear.) They met together, not as masters and men, but as friends and equals, with only one aim, to do all they possibly could to promote the well-being and interests of those connected with their industry. (Cheers.)

MR. T. W. MARKLAND, after referring to the many good points in their President, said they tried at the monthly meetings to educate one another, and they could do nothing better, for that which they gave to others they received back in some shape or form. (Hear, hear.) They all had their difficulties, for there were more difficulties in the foundry trade than in any other part of the engineering industry, and it was their common duty to help in solving them. The education or training which the boys needed was not given in the Manchester Technical School, but he hoped to see the day when such training would be given, not only in Manchester, but in all technical schools where it was wanted. (Applause.)

MR. R. W. KENYON proposed "The Visitors," and MR. J. H. STUBBS replied.

The CHAIRMAN said they had made good progress in the Branch during the past year, and now had 169 members. He would promise them to do all in his power during his year of office to increase the number still further.

Foundry Troubles.

Before the Superintendents' and Foremen's Division of the Manufacturers' Association of Chattanooga, Tennessee, U.S.A., on January 6, Mr. David McLain, the well-known semi-steel expert, discussed "Conditions the Average Foundry Owner is Up Against." An abstract is given herewith :—

Many manufacturers have been accustomed to standards, covering nearly every part of a machine, but the foundry often does not pay as close attention to standardising. There is no standardising in those foundries that have been run on old foundry traditions, such as the foundry making general jobbing castings, but purchasing pig-iron by number, instead of specifying that the iron must contain certain percentages of elements best suited for the castings made in the shop. The foundryman who buys iron on specification is protected, but the firms who purchase iron by number may receive iron that is not that which they expected. The successful mixer of irons must know what effect a given quantity of one element will have on the others, and must buy pig-iron most suitable for his particular line of work when he knows how. He should beware of indiscriminate buying of scrap iron, as tons of inferior material is despatched when miscellaneous scrap is bought. When a casting is lost by a crush, a drop, or by not being securely clamped, this certainly may be blamed on the moulder; but when the irons are mixed and melted right, pin-holes and so-called blow-holes will disappear. Every mould properly made, closed, clamped and poured carefully should produce a good casting, providing the mixture is right.

Discussing the addition of steel to cupola mixtures, Mr. McLain referred to the puzzling statement found in standard text-books, to the effect that carbon in molten iron is all combined. He said :—Now I feel positive the gentleman who wrote this first must have made a mistake, and it has been much easier for later writers to copy his remarks than to work the puzzle to a satisfactory conclusion. I believe the originator of this claim merely referred to white iron, or iron with at most a very small amount of silicon. At one time, believing the same, I have often been puzzled when pouring light, thin sections. These castings set almost instantly, but analysis has proved that there was scarcely any combined carbon, providing it was a soft mixture. A medium-soft mixture, of course, would have more combined carbon, and a hard mixture a greatly increased amount of combined carbon.

Years ago chemists and metallurgists, claiming that carbon in the molten metal was all in the combined form, kept unceasingly at the founder to regulate his mixtures by the carbon and insisted that the carbon be taken on every test. I could not agree with them. Carbon is the element that gives iron its characteristic qualities of hardness and softness, and may be controlled or regulated by silicon, the other elements, rate of cooling and scientific melting.

When I began experimenting with steel scrap in cupola mixtures thirteen years ago, I worked on the theory that if there was silicon in the mixture the amount of silicon would determine the hardness of the metal. It also became apparent that high manganese was necessary because manganese increases the saturation point of iron for carbon, and reduces sulphur when high, and to use a large percentage of steel in the mixture it was necessary to have a low sulphur content in the metal. Following my system, silicon may be much lower in semi-steel than if the same castings were made of good grey iron.

Lately a patent has been granted for a process for removing a percentage of sulphur from molten cast iron. The patentee claims to be able to reduce the sulphur content 30 to 50 per cent. He states :—"Many castings are lost on account of defective spots of various sizes, attributed to kish, sand or oxides, and analyses of these spots proved abnormal amounts of sulphur, manganese and carbon. By introducing air through a pipe with a $^1/_{16}$-in. hole in the bottom of the ladle of molten iron, this starts an ebullition creating manganese oxide, which, owing to its affinity unites with sulphur to produce a slag which rises to the top of the ladle, where it may be skimmed off. Analyses of the slags are shown containing a large increase of silicon, sulphur and manganese."

I have long advocated the use of manganese to reduce sulphur, but we remove the sulphur in the cupola where we "boil" the iron, and after it is run into the ladle, more impurities work up through the metal, and this slag produced in the ladle contains a large amount of manganese-sulphide slag.

Some machine-tool builders claim they chill the vees or guides, while others do not use chills at all. They talk of standardising, when selling their machines, but why don't they be consistent and standardise their mixtures? They do not require chills if the metal is close-grained. Semi-steel machines stand a high polish, not in spots, but all over.

It was not until 1900 that I became aware of the fact that few foundrymen were melting scientifically. The cupola is considered the "heart of the foundry." It is the point at which you make a profit or loss. The foundryman can be taught by an expert how to arrange any cupola, melt iron scientifically, and add to its value at each succeeding step; how to melt 12 to 15 lbs. of iron with 1 lb. of coke between charges; just what amount of iron and coke should be charged, and how to melt iron quickly, in many instances cutting total time of heat from a half-hour to an hour or more.

Effect of Foreign Metals on the Rolling of Zinc.

Experiments have been conducted in Belgium with a view to discovering the effect of foreign metals on the rolling of zinc. Ingots weighing 40 pounds were prepared by casting together zinc alloys of various metals, with spelter containing lead 1.05 to 1.25, cadmium 0.076 to 0.11, and iron 0.03 to 0.039 per cent. It was found that cadmium is harmful above 0.25 per cent., while with 0.5 per cent. rolling is impossible. In regard to arsenic 0.02 per cent. markedly increases the hardness, and with 0.03 per cent. the metal is too brittle for practical purposes. Antimony is less objectionable than arsenic as regards hardness, as 0.07 per cent. does not increase the hardness; but 0.02 per cent. is enough to produce a striated surface on the rolled sheet, which makes it unsaleable. Tin is objectionable when above 0.01, and prohibitive at 0.03 per cent. Copper has no hardening effect until it reaches 0.08, and with 0.19 per cent. the zinc is unworkable. A permissible maximum of iron is 0.12 per cent., but this is easily reduced in refining. Though 1 to 1.25 per cent. of lead does not interfere with the rolling, a slight increase not only seriously affects malleability, but the excess of lead remains unalloyed and forms patches on the sheet. The presence of two or more impurities together results in a combination of the injurious effects of each.

Inventions.

Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

28,345. Melting-furnaces and apparatus for stirring or agitating molten material therein. I. Hall.
28,440. Production of pure iron, pure iron alloys, and phosphorised pure iron and alloys. R. B. Carnahan, jun.
28,492.*Process for the preparation of alloys. L. Sempell.
28,526.*Jigging moulding-machines. C. Oetling.
28,571.*Method of working pure iron. R. B. Carnahan, jun.
28,575. Discharging copper from refining furnaces. E. John.
28,579.*Drying-apparatus for casting-moulds. C. A. Aahman.
28,585. Operating die-casting apparatus. P. T. J. Estler.
28,593. Hot working iron and iron alloys. R. B. Carnahan, jun.
28,606 and 28,607. Manufacture of iron. R. B. Carnahan, jun.
28,907. Working steel converters. T. J. Heskett.
29,399. Making foundry moulds. G. D. Peters & Company, Limited, and F. C. Hibberd.
29,525. Metal furnace. I. Hall.
29,602.*Production of annular cast plates for the production of wire. G. Höper.
29,634.*Alloys of iron. J. R. Speer and W. L. Forster.
29,813.*Furnaces for melting metals. J. Lambot.
30,084.*Producing hollow metal bodies by casting. (Hydra Patent Verwertungages m. b. H., Germany.)

1914.

47. Milling machines. J. A. Paterson and Widnes Foundry Company, Limited.
226.*Electric furnaces. I. Rennerfelt.
570.*Electric induction furnaces. J. Härdén.
856. Furnaces. C. Zulver.
874. Manufacture of manganese steel and articles thereof. Sir R. A. Hadfield.
892. Casting metals. F. H. Trier.
910. Testing the hardness of metals or alloys. Rudge-Whitworth, Limited, and H. L. Heathcote.

Abstracts of British Patent Specifications recently Accepted.

2,484 (1913). *Process and Apparatus for the Thermal Treatment of Steel Ingots and Castings.*—Società Anonima Italiana Gio. Ansaldo & Company, 2, Corso Andrea Podestà, Genoa, Italy.—This invention covers an improvement in the process for treating ingots or castings, particularly of steel, wherein the ingot or casting for the purpose of preventing piping is gradually cooled from the bottom upwards, the metal in the upper portion being retained in the liquid condition during the cooling of the portion below. The ingot or casting is heated by electric currents induced in the metal by means of an alternating current in a coil surrounding the metal to be treated.

28,960 (1912). *Regenerative Open-hearth Furnaces for Metallurgical Purposes.* Dr. K. Albert, 14, Landgrabenweg, Amöneburg, near Biebrich on the Rhine, Germany.—Figs. 1 and 2 are elevation (partly in section), and top plan view, respectively, showing one form of furnace. The waste gases during the period of volatilisation are utilised by means of a recuperator. Hence even during the period when the gases are charged with vapours arising from the metals or their oxides, the air for combustion is preliminarily heated to such a temperature, that the risk of explosions is removed and a sufficiently high temperature is obtained in the furnace. When the furnace is working normally the gases from the hearth-chamber H pass alternately through the right-hand and left-hand flues *a*, a^1, and the regenerators K serving for heating the air and the regenerators K^1 serving for heating the combustible gas and the main flue *b* to the smoke stack, whereas during the volatilisation of the metals in question the waste gases flow from the hearth-chamber H through the flue *c* and the recuperator R. A fan produces the necessary draft in this recuperator by way of the flue *d*. Obviously, during this period the flue *b* must be closed by the damper S. The metals or oxides are recovered from the waste gases in known manner by means of dust-chambers and filtration. The air preliminarily heated in the recuperator passes through the flue *e* to the furnace either directly by way of the flue *f*, or first by way of the flue *g* to the right-hand regenerator, in order to be heated still more highly there and then to be used for the combustion.

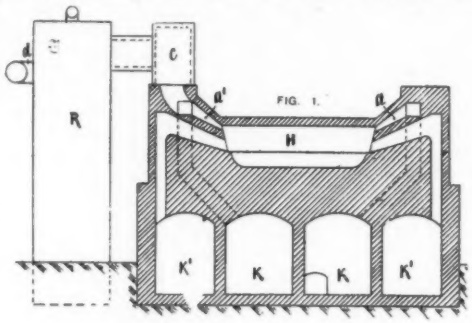


FIG. 1.

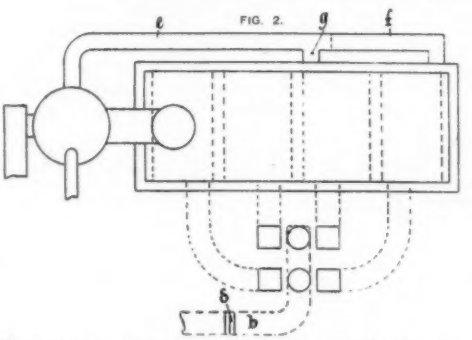


FIG. 2.

Regenerative Open-hearth Furnace for Metallurgical Purposes.

The preliminary heating of the air for combustion by such a recuperator does not suffice, however, for producing the temperature customary in the Siemens-Martin furnace, whereby the process of volatilisation is, of course, protracted. If the air preliminarily heated in the recuperator is conducted through the one regenerator K in addition for heating it still more, this regenerator is considerably cooled. The cooling of the regenerator causes, of course, a prolongation of the duration of the volatilisation of the metals and also of the subsequent Martin process, and thus a considerable prolongation of the heating of the entire charge. If it is wished to obviate this prolongation of the heating of the charge and nevertheless in each phase of the process to obtain the high preliminary heating of the air for combustion requisite for obtaining a hot flame, the furnace is not provided with a recuperator but with two pairs of regenerators for heating the air. These two pairs of regenerators are used alternately, the one being used for the volatilisation period of the metals and the other for the normal working of the furnace.

22,724 (1913). *Electric Furnaces.* E. Stassano, 35, Via Maria Vittoria, Turin, Italy. The inventions concerns mounting of rods for carrying electrodes in electric arc furnaces, and has for its object to provide an efficient electrode guide and a thorough cooling of all parts adjacent to the electrode. The claims of the patentee are as follows:—(1) An arrangement for mounting the electrodes in electric arc

furnaces, characterised by the rod to which the electrode is fixed being guided at its two ends, and the front wall of the chamber being cooled by the circulation of water in a manner to obviate the necessity of any play being provided in the aperture through which the electrode is passed. (2) The arrangement according to Claim 1, characterised by the rod carrying in front an insulated stirrup, which is provided with insulated wheels adapted to travel on two rails, themselves insulated and mounted on the bottom of the chamber, while at the rear end the carriage, connected to the controlling piston, rests on guides fixed to the wall of the chamber. (3) The arrangement according to Claim 1, characterised by a circulation of water being established opposite the front and rear walls of the electrode chamber also in the interior of the rod to which the electrode is fixed, by means of an insulated tube mounted in the interior of another tube also insulated within the rod and discharging opposite the connection with the electrode.

6,067 (1913). *Foundry Moulding Machines.* W. Kurze, Neustadt on the Rubenberge, near Hanover, Germany.—The present invention relates to a moulding machine on wheels, in which the moulding material is forced by means of compressed air into a mould or a mould flask, the material being moistened close to or outside of the mixing nozzle, as described in Specification No. 21,468[12]. The present invention provides that the frame supporting the water tank and the sand container with the mixing nozzle is displaceable on a rail and pivotally suspended, the sand container allowing of being separately turned and raised or lowered together with the mixing nozzle. The mixing nozzle can, therefore, be easily and conveniently moved to any desired point, so that it will be possible to quickly and conveniently fill all moulds and mould flasks in the foundry with the material. Provision is also made for enabling all movements of the moulding machine to be controlled from one single driving shaft. As essentially compressed air is supposed to be used for the moulding machine, this driving shaft will preferably be likewise driven by compressed air. The supporting disc and the wheels of the moulding machine, and also the supporting shafts for the mixing nozzle, are coupled in such a manner with the pneumatically driven driving shaft that the forward and backward travel of the whole machine, its swivelling and the raising and lowering of the mixing nozzle can be controlled from one point.

6,851 (1913). *Open-hearth Furnace Ports.* D. Carnegie, 33-35, Charterhouse Square, London, E.C.—The invention concerns improvements in cooling devices for protecting the ports of open-hearth furnaces. The general object of such cooling devices heretofore proposed in connection with open-hearth furnaces is to protect those parts of the furnace such as the ports, heads, uptakes and flues, through which hot gases and air pass to and from the furnace, the rapid wear of these parts as formerly constructed in the solid form of refractory material having necessitated frequent repairs. The destructive action referred to takes place principally at the extremity of the gas port next to the furnace where the gases enter the port when passing from the furnace, the cutting action of the intensely hot gases and the particles of metallic oxide carried by them being increased by the periodic reversals in the direction of flow of the gases. The object of the invention is to improve the construction and arrangement of the cooling devices, so that repairs may be more readily and cheaply effected, and the same degree of protection obtained it may be with a smaller quantity of cooling fluid. The invention consists in a removable port end composed of a series of sectional compartments or units for the cooling fluid, such units being structurally associated with the refractory walls of the port in such a manner that any one unit may be separately removed. The invention further consists in a separate control for the cooling fluid flowing through each of the units referred to in the preceding paragraph, so that the amount of cooling from point to point of the port wall may be adjusted to correspond with the requirements.

Catalogues, Etc., Received.

British Aluminium Company, Limited, 109, Queen Victoria Street, have forwarded copies of leaflets relating to (1) aluminium in the automobile chassis, (2) aluminium netting and gauze, and (3) aluminium mandrils for rubber manufactures.

The Westinghouse Cooper Hewitt Company, Limited, 80, York Road, Kings Cross, N., have issued a pamphlet relating to the Cooper-Hewitt "Rectigraph" for the rapid copying of drawings or documents without any possibility of error.

The Rapid Magnetting Machine Company, Limited, 18, The Crescent, Birmingham, have forwarded a new illustrated catalogue of their magnetting machines for foundry and other use. A number of different designs are illustrated and described, and as the firm have carefully specialised in this apparatus, the requirements of almost all conditions are met by the different designs.

An important development in the Lincolnshire iron and steel industry is foreshadowed in circulars issued by the directors of the Steel Company of Scotland, Limited, to the shareholders, recommending that the company should acquire one-half interest in the Appleby Iron Company, Limited, Scunthorpe, the other half interest being held by the Frodingham Iron and Steel Company, Limited, whose works are also situated at Scunthorpe. It is stated in the circular that the 5,000 issued shares of £10 each of the Appleby Iron Company were acquired by the nominees of the Frodingham Company in June, 1912. Since that date the Appleby Iron Company has been financed and carried on by the Frodingham Company, who are to receive a sum to cover their costs. It is proposed to increase the capital of the Appleby Iron Company to £800,000 in shares of £1 each, of which one-half will be ordinary shares. The proposed agreement provides that of these ordinary shares, the Frodingham Company and the Steel Company of Scotland will each hold 175,000, and the remaining 50,000 shares will be held, one-half by nominees of the Frodingham Company and one-half by nominees of the Steel Company of Scotland, Limited. It also includes the right to the Steel Company of Scotland to nominate one-half of the directors of the Appleby Iron Company. It is not proposed to issue the remaining 400,000 shares of the Appleby Iron Company in the meantime, but they are being created in order that they may be issued as preference shares if and when required. The Appleby Iron Company, it is further stated, at present carry on business as ironmasters, and their works at Scunthorpe are favourably situated for the purpose. A large supply of ironstone is available, and it is proposed to extend the existing works and to erect new works on an adjoining site for the manufacture of steel plates by the basic open hearth process. An agreement has been executed as between the three companies, subject to confirmation by the shareholders of the respective companies. A meeting of the shareholders of the Steel Company of Scotland, Limited, is called for the 4th prox. to consider the proposal, and, if approved of, to authorise the creation of 40,000 new 6 per cent. cumulative preference shares of £10 each, which will increase the capital of the company from £500,000 to £900,000. It is explained that it is not necessary to issue this new capital at once, but that it is proposed to take the formal step of increasing the capital in order to provide for the financial requirements of the scheme, and to enable the board, if so advised, to pay off the company's existing debentures. The first representatives of the Steel Company of Scotland, Limited, on the board of the Appleby Company, will be Messrs. Cassils and Thorneycroft, directors, along with the commercial manager, Mr. McSkimming, and the general works manager, Mr. Simpson.

Trade Talk.

GEO. SANDS & SONS, LIMITED, engineers and contractors, have removed their London offices to 31, Old Queen Street, Westminster, S.W.

MR. A. MACHARG, C.A., Glasgow, has been elected trustee of the sequestrated estates of William Young & Sons, engineers, Ardrossan.

MESSRS. G. W. GOODCHILD & PARTNER, engineers' agents, have removed to 56 and 58, Eagle Street, Southampton Row, London, W.C.

MR. O. PAUL MONCKTON, 87, Victoria Street, Westminster, London, S.W., has been appointed sole British agent for the Société Génèvoise.

W. T. GLOVER & COMPANY, LIMITED, of Trafford Park, Manchester, have removed their Newcastle business to 20, Westgate Road, Newcastle-on-Tyne.

THE premises of the Aston Brass Company & Whitehouse, Limited, Aston Lane, Lichfield Road, Birmingham, have been seriously damaged by fire.

MR. C. V. BRINDLEY, late chief chemist at Crossley's Motor Works, Manchester, has opened a metallurgical laboratory at 198, Effingham Street, Attercliffe, Sheffield.

MESSRS. THOMAS SMITH & SONS, of the Steam and Electric Crane Works, Rodley, near Leeds, have removed their London offices to 25, Victoria Street, Westminster, S.W.

CONSIDERABLE damage has been done by a fire which broke out on the premises of J. Tyler & Sons, Limited, engineers, Belle Isle, York Road, King's Cross, London, N.

THE co-partnership of Paterson & Miller, engineers, 143, Wellington Lane, Glasgow, of which Mr. W. C. Paterson and Mr. C. Miller were the partners, has been dissolved.

MR. A. W. MEINE, sole partner of the Metal Products Company, County Chambers, Corporation Street, Birmingham, proposes in future to carry on business under his own name.

MR. W. SPENCE HASWELL, engineer and agent, Milburn House, Newcastle-on-Tyne, has been appointed agent for Messrs. Youngs, engineers and ironfounders, Ryland Street, Birmingham.

THE shareholders of the Orion Steel Company, Sheffield, Limited, have decided to wind up the company voluntarily, and have appointed Mr. P. Toothill, 11, Figtree Lane, Sheffield, as liquidator.

RAU'S METAL WORKS, LIMITED, makers of ferro-alloys, etc., Pforzheim (Germany), have opened a branch at the Meadow Works, Sheffield, under the direction of Mr. W. Branfield, metallurgical engineer.

THE partnership heretofore subsisting between Messrs. W. Jarvis and S. Murgatroyd, carrying on business as engineers and machine tool makers, at Market Street Works, Keighley, under the style of Jarvis & Murgatroyd, has been dissolved.

THE BRITISH MANNESMANN TUBE COMPANY, LIMITED, have definitely decided to erect their new works at Newport, and have made an application to the Newport magistrates in connection with the widening and improving of the approaches to the site.

MESSRS. JOHN SHAW & COMPANY, of the Maryhill Ironworks, Glasgow, have converted their business into a private limited company, under the style of Shaw, Glasgow, Limited. This step will not involve any change in the management of the concern.

MR. J. WOTHERSPOON, jun., has retired from the co-partnership carried on under the style of the Etna Iron and Steel Company, of Motherwell. Mr. James Kerr, the remaining partner, will continue the business under the same name and discharge the liabilities.

THE co-partnership carried on by Mr. R. M. Hunter and Mr. H. D. Hunter under the style of Robert Hunter & Sons, Wallacetown Foundry, Ayr, has been dissolved. Mr. R. M. Hunter will carry on the business at the Wallacetown Foundry under the same name, and will discharge the liabilities.

THE partnership heretofore subsisting between Messrs. J. W. Harker and G. Hawkins, carrying on business as engineers and contractors, at 13, Billiter Street, London, E.C., under the style of John W. Harker & Company, has been dissolved. Mr. G. Hawkins will in future carry on the business under the same style.

JAMES CARTLAND & SON, LIMITED, of the Great Western Brassfoundry, Constitution Hill, Birmingham, have taken over the brassfoundry businesses of Loach & Clarke and Chance, Son & Company. Mr. R. R. Harrison, who was the sole partner of both concerns, has been elected a director of Jas. Cartland & Son, Limited.

A MEETING of the shareholders of the Waverley Iron and Steel Company, Limited (in liquidation) will be held at 86, St. Vincent Street, Glasgow, on February 18, for the purpose of having an account laid before them showing the manner in which the winding up has been conducted and the property of the Company disposed of.

NEGOTIATIONS are well forward for the removal of the Whitehead Iron and Steel Works from Tredegar to Newport. The site under consideration is one of about eighteen acres on the west side of the Usk, not far from the west end of the Alexandra Docks, close to the dock company's lines of railways, and also those of the Great Western Company.

WELLMAN, SEAVER & HEAD, LIMITED, have recently received orders from Bolckow, Vaughan & Company, Limited, in connection with the extension of their Siemens plant, including a 400-ton active mixer, 100-ton and 50-ton ladle cranes, each provided with a separate independent auxiliary trolley, and one platform-type rotating open-hearth charging machine.

MR. GEORGE ELLISON, engineer, of the Victoria Works, Warstone Lane, Birmingham, has opened a branch office at 4, Cannon Street, Manchester, to deal with the Lancashire and Yorkshire business. The branch will be under the management of Mr. W. A. Kirkham, who will have a staff of assistants capable of dealing with any enquiries for switchgear emanating from these areas.

AN amalgamation has been arranged between N. M. Höglund's Sons & Company and a new company, which has been registered in Sweden as Aktiebolaget the Swedish Trading Company, with a capital of about £110,000, to carry on the business of exporters of Swedish iron and steel, etc. The company are represented in this country by Mr. Charles Yeomans, 7, Parade Chambers, High Street, Sheffield.

THE first of a series of six lectures on "Brass, Bronze and Other Alloys" was given on January 13 in the Armstrong College, Newcastle, by Dr. Cecil H. Desch. There was a fairly large attendance. The lectures are under the auspices of the Newcastle section of the Society of Chemical Industry and Armstrong College, and the second lecture was delivered on January 27, the others following on February 10 and 24, and March 10 and 24.

THE SOC. HAUTS-FOURNEAUX ET FONDERIES DE PONT-A-MOUSSON, of Pont-a-Mousson, France, whose London representatives are now Sophus Berendsen, Limited 155, Fenchurch Street, E.C., has now an annual output which includes 3,000,000 tons of iron ore, 330,000 tons of steel-making and foundry pig-iron, and 200,000 tons of castings, of which 150,000 tons are vertically-cast pipes, from 1¼ in. to 60 ins.

AT a meeting of the shareholders of Rankin, Steven & Company, Limited, Budhill Foundry, Shettleston, Glasgow, resolutions were passed to the effect that it had been proved to the satisfaction of the company that it could not by reason of its liabilities continue its business, that it was advisable to wind up the same voluntarily, and that Mr. James Wilson, 61, West Regent Street, Glasgow, be appointed liquidator.

THE annual dinner of the Keighley Association of Engineers took place on January 17, with Mr. J. Crabtree in the chair. Those present included Mr. A. Sellers, Mr. Longsdon, Professor W. H. Watkinson (Liverpool University), Mr. H. S. Clough (president of the Keighley Chamber of Commerce), Mr. Jonas Bradley, Professor Charnock (Bradford), Mr. William Atkinson (Leeds Association of Engineers), Mr. E M. James, and Sir Swire Smith.

NOTICE is given that the names of the undermentioned companies have been struck off the Register of Joint Stock Companies and such companies are dissolved.

Brettell, Wanklin & Company, Limited, British Electro Metallurgical Products Company, Limited, Chas. H. Hampshire, Limited, Connaught Coal and Iron Syndicate, Limited, Finsbury Engineering Works, Limited, G. & A. Menzies, Limited, Hadfield's, Limited, Kourna Iron and Akoumiani Yalia Coal Mines, Limited, and the Whittington Welding Company, Limited.

A MEETING of the honorary committee of experts in connection with the Shipping, Engineering and Machinery Exhibition, at Olympia, has been held at the Connaught Rooms, Queen Street, London, W.C. Mr. Charles H. Luke, joint managing director of the Exhibition, who was in the chair, introduced Dr. Bisschop, chairman of the Royal Dutch Commission, and Mr. de La Vallette (the British Maritime Agency, Limited), hon. secretary of the Royal Dutch Commission. Dr. Bisschop briefly traced the events which led to the appointment of the Royal Commission by the Dutch Government. He mentioned that the Burgomaster and the Corporation of the City of Rotterdam had devoted the sum of over £3,000 towards making an adequate display of the vast harbour works of that city. It was proposed that Sir Archibald Denny, Bart., should be asked to become chairman of the committee. Mr. A. Boyle, consultative branch of the Board of Trade, was elected vice-chairman, and Mr Charles H. Luke, secretary.

AN interesting paper on the corrosion of iron and steel was read by Mr. F. Crosby-Jones before the members of the Institute of Marine Engineers. According to the author, iron and steel, by their nature, were such that were it possible to incorporate with them some ingredient that would prevent corrosion, it would entirely alter their construction, and would probably render them useless for many of the purposes to which they were now put. The available methods were coating the surfaces (a) by a non-corrodible, or less corrodible metal, or by a metal that corroded and being electro-positive to iron would protect them; (b) by coating with porcelain enamels, which were afterwards stoved; (c) by an oxidising process; (d) by Portland cement; (e) by paint, varnish, or bituminous solutions or compositions. Structures should be composed of the same metal as far as other considerations would allow; surfaces should be even and free from depressions, cracks, and crevices, wherein water could lodge; pockets that allowed of the collection of water should be avoided: all members should have free air circulation about them; provision should be made where necessary for the drainage of water; joints, rivet heads, bolts, and nuts should be given special attention to ensure exclusion of water, and all parts that were not easily visible should have careful inspection.

BEFORE the Coventry Engineering Society on January 9 Dr. W. H. Hatfield (director of J. Crowley & Company, Limited, Sheffield) dealt with the commercial alloys of iron and carbon and generally discussed the whole range of the iron and iron carbide equilibrium diagram. After illustrating the micro-structure of varous pig-irons, he discussed the influence of varying microstructure upon the physical and mechanical properties of iron castings in both the cast and annealed conditions. He then proceeded to deal with malleable castings as produced both in Europe and America, and by a series of slides indicated the influence of variation in composition both upon the method of production and final product. Comparisons were made between properly-precipitated malleable iron and wrought iron and the great similarity between the two types of material was brought out. In conclusion the lecturer discussed the metallurgical problem of producing small steel castings which is now having attention, and amongst other slides illustrating this part of his subject he exhibited several showing the structure obtained in very small steel castings when cast, as they needs must be, from very high temperatures; it was then indicated that such material, as would be seen from the lack of homogeneity existing in the cast condition, should be thoroughly annealed, particularly when the uses for which castings were intended were fully considered.

Deaths.

MR. HUGH MARTIN, engineer, of Whiteshaw, near Carluke, has died at the age of 67 years.

THE death is reported of MR. I. PRESTON, anchor manufacturer, of the Anchor Works, Cradley Heath, Staffordshire.

THE death is announced of Mr. J. M. Wilson, secretary of Ransomes & Rapier, Limited, Waterside Iron Works, Ipswich.

MR. H. R. ROGERSON, works manager at the Calderbank Steel Works, Airdrie, died at Edinburgh on January 24, aged 35 years.

MR. J. GRESHAM, a director of the firm of Gresham & Craven, Limited, engineers, South Hall Street, Ordsall Lane, Salford, Manchester, has died at his residence, Woodheys Park, Ashton-on-Mersey. The deceased gentleman was a former president of the Manchester Association of Engineers.

THE death has occurred in London of Mr. R. G. Evered, joint managing director of Evered and Company, Limited, brassfounders, etc., of the Surrey Works, Smethwick, near Birmingham. In addition to his active career in connection with Messrs. Evered's business, the deceased gentleman was Chairman of the Conciliation Board in the brassfounding trade.

MR. J. H. R. TASKER, of Sheffield, died on January 17, after a brief illness. The deceased gentleman was the chairman of Taskers Engineering Company, Limited, of Blonk Street and Portmahon Works, Sheffield, and came of an old family which has been prominently associated with the development of the engineering industry in Sheffield. He was 65 years of age.

THE death occurred on January 2, at his residence, Lower Church Lane, Tipton, of Mr. Joseph Mason, of George Gadd & Company, Limited, Church Lane Ironworks, Tipton, a well-known and widely-respected ironmaster. For upwards of forty years he had been a prominent figure in all that concerned the iron industry of the Midlands, and his death at the age of 76 was not unexpected, though after only a short illness.

MR. G. H. LLOYD, who recently resided at Sutton Coldfield, has died at Eastbourne. The deceased gentleman, after serving his apprenticeship to engineering at a works in Middlesbrough, became associated in the year 1871 with Thomas Piggott & Company, Limited, and continued on the board until about six years ago.

MR. F. TURNER, of E. R. and F. Turner, Limited, engineers and ironfounders, St. Peter's and Grey Friars' Works, Ipswich, died recently, at the age of 82 years. His father was a partner in the firm of Bond, Turner and Hurwood, engineers, to which firm the deceased was apprenticed. He remained with this company, the style of which was changed to E. R. and F. Turner about 1852, all his life, with the exception of two years, latterly becoming chairman.

MR. H. E. MARSH, eldest son of Mr. H. P. Marsh, of Sheffield, died on January 10, at his residence, 26, Lawson Road, Sheffield. Mr. Marsh, who was only 32 years of age, had not been very well recently, but he was at work during last week. It was only on January 9 last that he was taken seriously ill, and he died in a few hours. Mr. Marsh was trained as an engineer at the Lancashire and Yorkshire Railway Works at Horwich, and at Schenectady, U.S.A. Since he came back from America he has been a director of Marsh Bros. & Company, Limited, Ponds Steel Works, Shude Lane, Sheffield.

THE death has taken place at his residence, Crawford Park, Dunblane, after a short illness, of Mr. Dermont Campbell, a director of the ironfounding firm of Jones and Campbell, Limited, of Larbert. Mr. Campbell, who was about 58 years of age, was a native of Hamilton. Over 40 years ago he entered the Glasgow office of Messrs. Dobbie, Forbes & Company, ironfounders, Larbert, and some three years later was appointed to a position at Larbert which he held for about 13 years, when he relinquished it to commence business as an ironfounder at Larbert with Mr. James Jones, Torwood Hall.

Personal.

MR. C. J. PATERSON has been appointed an inspector of factories and workshops.

MR. WM. BARTON, of Stafford, has been elected a director of W. H. Dorman & Company, Limited.

MR. R. G. SCOTT, manager of the steel department of the Monk Bridge Iron and Steel Company, Limited, has resigned.

THE late MR. H. M. Biggleston, of Messrs. Biggleston & Sons, ironfounders, Canterbury, left estate valued at £34,622 gross.

MR. C. E. BILLINGHAM, 5, East Park Avenue, Cardiff, has been appointed mechanical engineer to the Cardiff Railway Company.

THE late Mr. W. Ballantyne, a director of the Airdrie Iron Company, Limited, left personal estate in the United Kingdom valued at £12,385.

THE late Sir William H. Bailey, chairman of W. H. Bailey & Company, Limited, Albion Works, Salford, left estate of the gross value of £68,313.

MR. W. B. LEECH, of the firm of Messrs. Leech, Goodall, and Company, engineers, of Hunslet, Leeds, has been appointed to the position of manager of the Leeds gasworks.

MR. J. DAVISON, chief engineer and works manager to Browett, Lindley & Company, Limited, of Patricroft, near Manchester, has secured an appointment with Mather & Platt, Limited.

The official lists of New Year honours are somewhat barren of names familiar in the iron and steel and engineering industries. The new baronets, however, include Mr. Wm. Beardmore, chairman and managing director of Wiliam Beardmore & Company, Limited, a director of Merry & Cunninghame, Limited, and Vickers, Limited.

New Companies.

FERRUM, LIMITED.—Capital £25,000 in £1 shares, to carry on the business of ironmasters, steel makers and converters, etc.

QUALITY PRICE, LIMTED.—Capital £500 in £1 shares, to carry on the business of general engineers. Registered office :—28, Denman Street, London, S.E.

COX BRASS MANUFACTURING COMPANY, (FRANCE), LIMITED.—Capital £5,000 in £1 shares. Registered office : 43, Regent Square, King's Cross, London, W.C.

JAMES ABERNETHY & COMPANY, LIMITED.—Capital £50,000 in £1 shares (25,000) preference), to acquire and carry on the existing business of engineers and boilermakers.

ALEXANDRA ELECTRICAL AND ENGINEERING WORKS, LIMITED.—Capital £500 in £1 shares, to take over the business of the Alexandra Electric Works, of Station Road, Letchworth.

WESSEX ENGINEERING COMPANY LIMITED.—Capital £20,000 in £1 shares, to acquire certain British and foreign patent rights of and relating to improvements in internal combustion engines, etc.

SNERCOLD ENGINEERING COMPANY, LIMITED.—Capital £27,000 in £1 shares, to adopt an agreement with the Safety Device Syndicate. Registered office : Snercold Engineering Works, Hampton Wick.

BLACKETT, HUTTON & COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of ironmasters, iron and steel founders, etc. The first directors are J. T. Blackett and W. Hutton.

DE ROS OIL FURNACES, LIMITED.—Capital £1,000 in £1 shares, to adopt an agreement with Dudley de Ros. First directors : N. V. P. Poirin and Dudley de Ros. Registered office : 44, Chancery Lane, London, W.C.

LOXLEY STEEL WORKS, LIMITED.—Capital £15,000 in £1 shares (5,000 pref.), to take over the business carried on by the Loxley Steel Works, Wisewood, Sheffield. Registered office : Loxley Steel Works, Wisewood, Sheffield.

ALDWYCH IRON COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of metal merchants and founders, etc. First directors : B. I. Hellyer and R. S. Hellyer. Registered office : Harpur Yard, Theobalds Road, London, W.C.

WILLIAM KNOTT & SON, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of ironfounders, etc. The subscribers are : S. Knott, Moss Bank, Slade Lane, Levenshulme, Manchester, and Mrs. E. A. Knott, Moss Bank, Slade Lane, Levenshulme, Manchester.

J. B. SLEATH & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of mechanical, electrical, hydraulic, etc., engineers, and to adopt an agreement with J. B. Sleath and H. D. Barnard. The first directors are J. B. Sleath and H. D. Barnard. Registered office :—71, Roscoe Street, Liverpool.

CAST IRON BRAZIERS AND METALLURGISTS, LIMITED.—Capital £2,000 in £1 shares, to take over the business of a brazier of cast iron carried on at 2, Gough Street, Elm Street, Gray's Inn Road, W.C., and to adopt an agreement with Count Callimachi. Private company. The first directors (to number not less than two or more than seven) are to be appointed by the signatories.

DAVID MANUFACTURING COMPANY, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of mechanical and electrical engineers, etc., and to adopt an agreement with G. H. Attenborough and E. W. Brown. The first directors are : E. W. Brown and G. W. Attenborough. Registered office :—8 and 9, Gray's Inn Passage, Red Lion Street, London, W.C.

MANSFIELD ENGINEERING COMPANY, LIMITED.—Capital £10,000 in £1 shares, to take over the business of mechanical and electrical engineers, etc., carried on by J. W. Houfton and C. A. Houfton, at Mansfield and elsewhere, as the Mansfield Engineering Company. The first directors are : J. W. Houfton and C. A. Houfton. Registered office : Recreation Street, Mansfield, Notts.

MATTHEW HARVEY & COMPANY, LIMITED.—Capital £25,145 in £5 shares to take over the business of brass and nickel casters and founders, etc., carried on by Matthew Harvey & Company, and to adopt an agreement with the said company and F. Harvey, its liquidator. The first directors are Mr. M. Harvey and Mr. F. Harvey (both permanent).

C. H. A. R., LIMITED.—Capital £3,300 in 3,000 ordinary shares of £1 each and 6,000 deferred shares of 1s. each, to carry on the business of ironfounders, etc., and to acquire from Messrs. Ricardo and Hetherington certain patents and inventions relating to two-cycle internal combustion engines, blower and pneumatic tools, etc. Registered office :—7, Princes Street, Westminster, London, S.W.

LEONARD W. HOLMES & PARTNERS, LIMITED.—Capital £1,000 in £1 shares, to take over the business carried on by L. W. Holmes and others, and to carry on the business of owners of patents, technical advisers, electrical and mechanical engineers, etc. The first directors are L. W. Holmes (governing director), H. M. Harris and P. A. E. Armstrong. Registered office : 48, Great Russell Street, London, W.

PITTERS VENTILATING AND ENGINEERING COMPANY, LIMITED.—Capital £30,000 in £1 shares (12,000 preferred participating), to carry on the business of ironfounders, etc., and to acquire from Pitters Patents, Limited, certain exclusive licences in respect of improvements in the construction of propellers as applied to ventilating. The first directors are : The Hon. Schomberg C. Trefusis, P. C. Clegg, and W. C. Pitter.

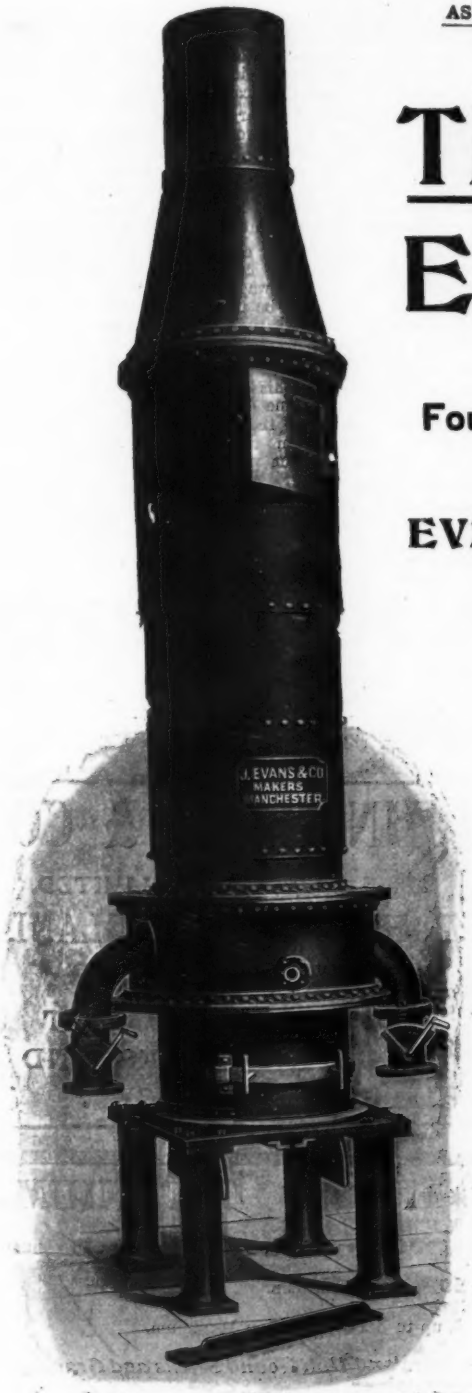
MARLEY BROTHERS, LIMITED.—Capital £5,000 in £1 shares, to take over the business of brassfounders, lock furniture manufacturers, and architectural metal workers carried on at Viaduct Works, Thimble Mill Lane, Aston, Birmingham, as Marley Brothers. The subscribers are : W. E. Marley, 15, Wellington Road. Handsworth Wood, Birmingham, brassfounder; L. C. Marley, 272, Kingsbury Road, Gravelly Hill, Birmingham, works manager. Registered office : Viaduct Works, Thimble Mill Lane, Birmingham

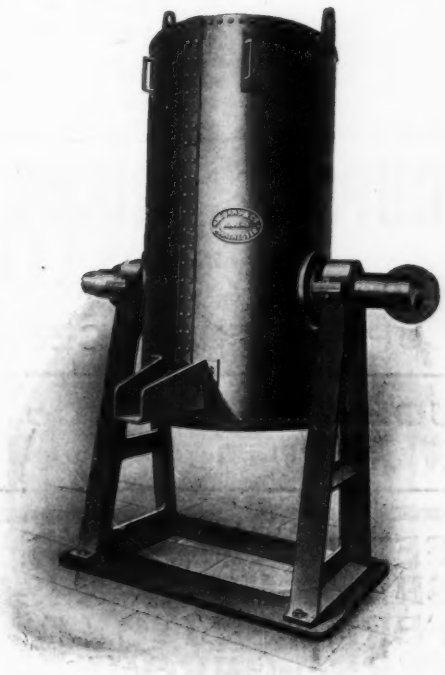
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Wages of Iron and Steel Moulders.

The Home Secretary has issued Order No. 1,388, dated December 30, 1913, applying the provisions of Section 116 of the Factory and Workshop Act, 1901, (1 Edw. 7, c. 22), with modifications, to works in which iron or steel founding is carried on so far as concerns the work of moulders. The following is the text of the Order :—

The said section shall be modified so as to read as follows :—

(1.) The occupier or contractor shall, for the purpose of enabling each worker who is paid by the piece to compute the total amount of wages payable to him in respect of his work, cause to be published particulars of the work and rate of wages applicable thereto, as follows :—

(*a*) He shall furnish every worker with written particulars of the rate of wages applicable to the work done by him at or before the time of his first employment on the work and on every subsequent occasion when the rates are fixed or altered; or he shall exhibit such particulars in a placard or book in the factory or workshop. Provided that if the rates are not ascertainable before the work is given out, the particulars shall be furnished to the worker in writing when the work is completed.

(*b*) Such particulars of the work to be done as affect the amount of wages payable to each worker shall be furnished to him in writing when the work is given out; or, at the option of the employer, such particulars as aforesaid of work done may be furnished in writing at or before the time when payment is made for such work.

(2) Where the work is done in common by a gang of workers it shall be sufficient if the particulars of the work done by the gang and of the rate of wages applicable thereto are furnished to the member of the gang to whom the wages of the gang are paid by the employer; or, when the share of each member is paid direct to him by the employer, to the leader of the gang, but in the last-mentioned case the particulars furnished of the rate of wages shall include particulars of the proportion according to which the shares of the several members of the gang are calculated.

(3) The particulars, either as to rate of wages or as to work, shall not be expressed by means of symbols; but this shall not prevent the occupier or contractor from describing any work which is of a standard kind known to the persons employed by a particular figure, number, letter or name, or combination thereof, by means of such figure, number, letter or name, or combination thereof.

(4) Any placard or book exhibited in pursuance of the foregoing provisions shall contain no other matter than particulars of rates of wages and shall be affixed or kept as the case may be in such a position as to be easily accessible to and read by all persons to whose work the particulars relate.

(5) If the occupier or contractor fails to comply with the requirements of this section, he shall be liable for each offence to a fine of not more than ten pounds, and, in the case of a second or subsequent conviction within two years from the last conviction for that offence, not less than one pound.

(6) If anyone engaged as a worker in the aforesaid class of work, having received such particulars, whether they are furnished directly to him or to a fellow workman, discloses the particulars for the purpose of divulging a trade secret, he shall be liable to a fine not exceeding ten pounds.

(7) If anyone for the purpose of obtaining knowledge of or divulging a trade secret, solicits or procures a person so engaged to disclose such particulars, or with that object pays or rewards any such person, or causes any person to be paid or rewarded for so disclosing such particulars, he shall be liable to a fine not exceeding ten pounds.

This Order shall come into force on March 1, 1914.

CUPOLA BRICKS
FOR LINING
ORDINARY AND PATENT
CUPOLA FURNACES.
JOHN R. FYFE & Co.,
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OF STOURBRIDGE, LIMITED.
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FERRO-VANADIUM. * * * FERRO-TITANIUM.
SILICO-MANGANESE {23/30 % Silicon, 65/70 % Manganese & 1 %, 2 %, 3 %, Carbon Maximum.
FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.
FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.
ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*
WE SUPPLY ALL CLASSES OF MINERALS, METALS AND METALLIC ALLOYS.
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TRADE SIROCCO MARK

CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

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Sirocco Engineering Works,

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	End Jan., 1914.	End Jan., 1913.
IRON—Scotch pig warrants ton	..... *56/9	..... *71/4½
—Middlesbro' warrants ton	..... 50/10	..... 65/9
—W.C. M/nos Bessemer ton	..... 65/9	..... 86/6
—Stock, Middlesbrough tons	 135,277	 236,595
COPPER—Chili bars GMB ton	..... £65 15 0	.... £60 2 6
—Stock, Europe and afloat tons	 26,694	 43,101
TIN—English ingots.. ton	.....£182 0 0	....£233 10 0
—Straits .. .. ton	.....£181 5 0	....£230 5 0
—Stock, London, Holland U.S.A., and afloat.. tons	 17,351	 14,875
LEAD—English pig .. ton	.....£20 10 0	.... £17 0 0
SPELTER—Ord. Silesian ton	.....£21 11 3	.... £26 5 0
QUICKSILVER (75lb.).. bottle	..... £7 10 0	.... £7 15 0
ANTIMONY—Regulus ton	£28 0 0 £30 0 0	£38 0 0 £40 0 0
ALUMINIUM—Ingot .. ton	.....£86 0 0	.... £89 0 0

* Settlement price.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.	£ s. d.
Columns (plain)..	7 7 6	to 7 12 6
Pipes, 1½ to 2½ in.	6 5 0	to 6 10 0
,, 3 to 4 in.	5 17 6	to 6 0 0
,, 5 to 8 in.	5 12 6	to 5 15 0
,, 10 to 16 in.	5 15 0	to —
,, 18 to 24 in.	5 15 0	to —
Chairs	4 5 0	to 4 6 0
Floor plates (open sand)	3 10 0	to 3 12 6

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 10s. 0d.; all per ton, f.o.b., London. Copper (clean), £59 0s. 0d.; brass (clean) £41 0s. 0d.; lead (usual draft), £18 5s. 0d.; zinc, £16 0s. 0d.; all per ton delivered merchant's yards.

AT a meeting of the shareholders of the Herbert Frood Company, Limited, held at 22, St. Anne's Street, Manchester, the following resolution was duly passed :—"That it is desirable to reconstruct this company, in accordance with the scheme embodied in an agreement, dated December 23, 1913, and made between Harry Willmott and Robert Whitehead of the first part, Joseph Bell and others of the second part, and this Company of the third part, and accordingly that this Company be wound up voluntarily; and that William Arthur Horrocks, of Thorn Loe, Chapel-en-le-Frith, in the county of Derby, Secretary, be and he is hereby appointed liquidator for the purposes of such winding-up."

FANS AND BLOWERS AND OTHER FOUNDRY MACHINERY FOR SALE.

BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11½" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 19" discharge, also 9½" round outlet to fit on same.
14" Schiele patent Blast Fan.
Lloyd's patent Blowing Fan for 50 smiths' fires.
New Roots pattern Blower, 5".
Silent Blowing Fans, 8½", 8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

CHARLES D. PHILLIPS,

EMLYN & CENTRAL ENGINEERING WORKS, NEWPORT, MON.

BLOFIL

THE

IRON CEMENT

(Quick or slow setting grades)

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THE CHEAPEST

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MOST RELIABLE

for all purposes.

Unaffected by oil, steam, or water.

Sole manufacturers—

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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams : "LOWOOD, DEEPCAR."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

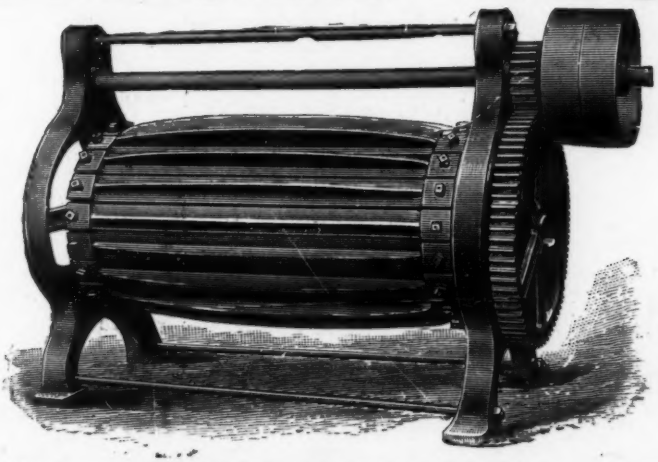
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



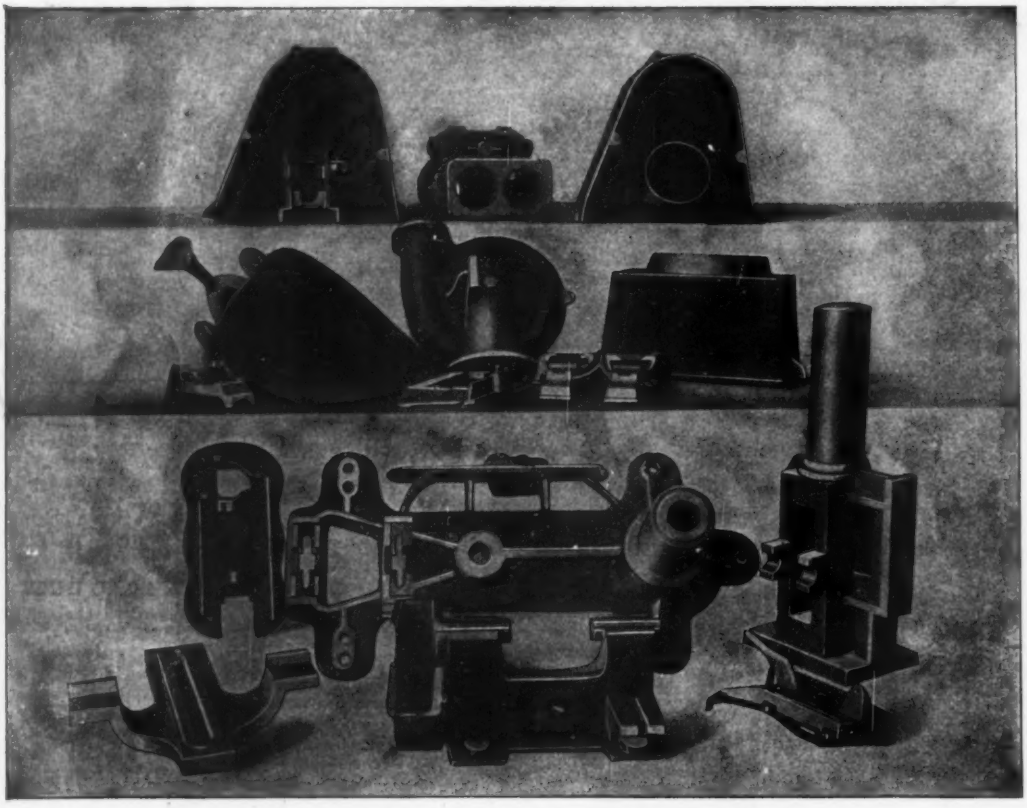
These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MACHINE MOULDED CASTINGS.



Do any of these castings interest you? Drop us a line and we will tell you the type of machine and the number of boxes put down per day of any of the castings shewn. In addition to these we have made machines and patterns for hundreds of other castings and will be pleased to send information as to the best machine for your requirements on receipt of particulars.

Our range of Hand, Hydraulic, Pneumatic and Electric Moulding Machines cover the requirements of any foundry.

It will cost you a penny stamp only to post your enquiry, the result will probably mean a saving of hundreds of pounds, less anxiety through 1914 and a better balance sheet in 1915.

SAND BLAST PLANTS. SAND PREPARING MACHINES. CORE MAKING MACHINES.
Call and see them at work.

THE LONDON EMERY WORKS Co., PARK WORKS,
TOTTENHAM. LONDON. N.

Passenger Station, Park G.E. Rly. **Telephone: Tottenham, 158.**

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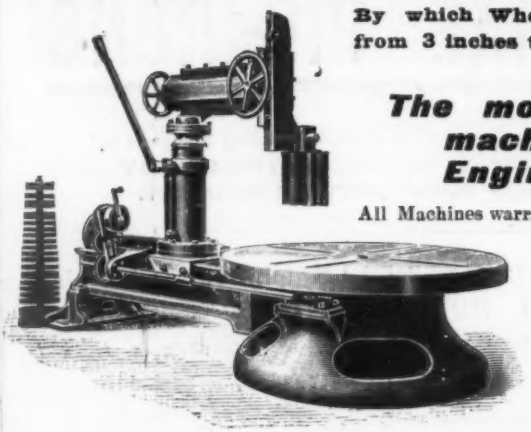

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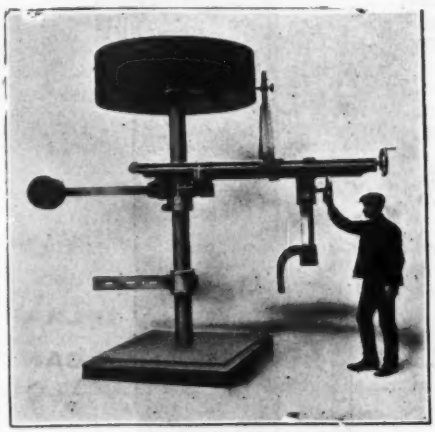

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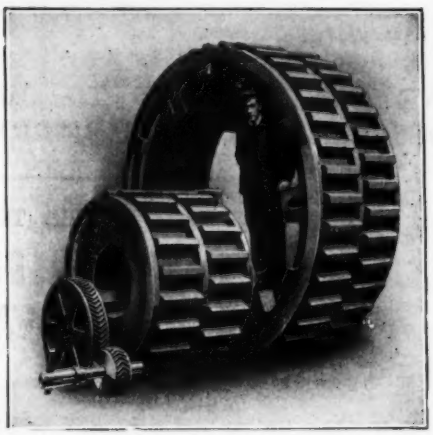

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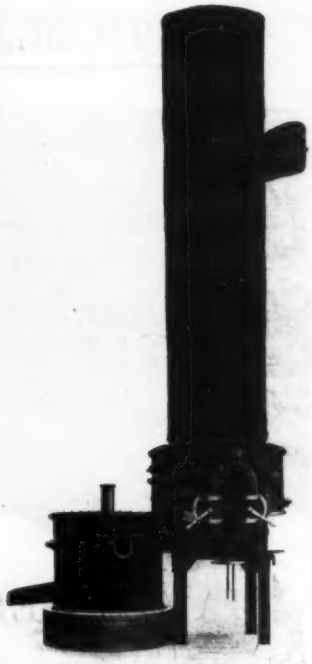

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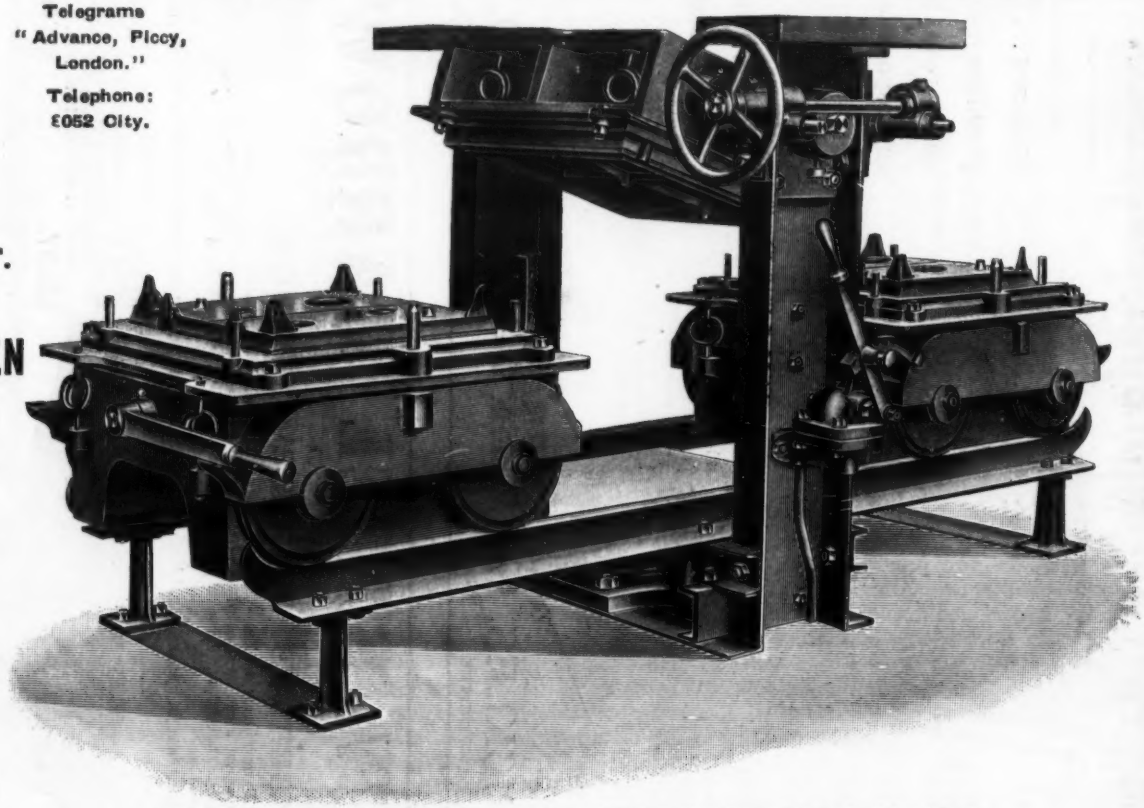

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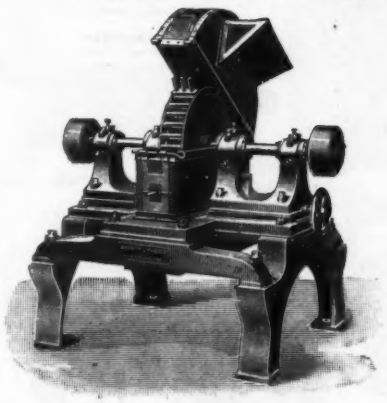

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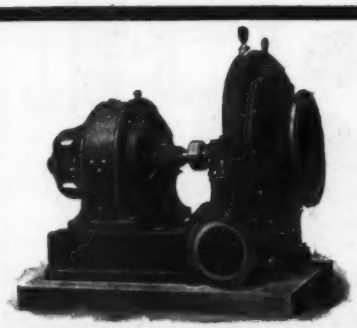

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